Elegant Experiments

Practical Science made easy for teachers and students.
Chemistry, Physics, Biology and Geology for junior and senior school science.

Volume II

By Greg Reid

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Volumes I and II form a complete nucleus for high school science.
Volume III will be available in 1999 and will contain unusual experiments and added variety.
Further copies can be obtained at $45 per volume, orders to:

Innotek Enterprises
PO Box222
Nimbin,
NSW, 2480

USING THIS BOOK

These books are intended as a user friendly resource for teachers to encourage "hands on science". The experiments can easily be incorporated when developing new programs, responding to a new syllabus or to enrich current programs.

While handing photocopy experiments to students may seem too easy, there are advantages beyond time saved to teachers. I have found that writing up lengthy procedures merely fragments student topic notes and the time consumed in writing directions often means the activity is rushed with conclusions poorly addressed.

EXPERIMENTS

The experiments are listed alphabetically by name to make them easy to find, however I draw your attention to the INDEX BY TOPIC at the end of the book. The topic index covers both volumes and lists experiment names under topics to which they are related. The purpose of the topic index is so you can quickly find experiments relating to a particular area of study. Rather than complicate the index by duplicating junior and senior topics, common topics appear only once with both junior and senior experiments appearing below.

If you have any good experiments not appearing here, please write to me and I will try to ensure ensure they are available to the struggling new generation of teachers.

TEACHER COPY

This copy includes related science topics, hints, controls, expected results, example conclusion, diagram , and risk assessment.

STUDENT COPY

This copy has space for written results and conclusions. Diagrams are included if the instructions are not sufficiently clear, otherwise the students should draw the equipment or use the space for a results table. A risk assessment is not included since this may unduly alarm some students and parents. The teacher should read the risk assessment to the class before beginning the experiment.

EQUIPMENT

I have tried to include <u>all</u> the equipment needed in each experiment. Concentrations are given in percentages so you are not constantly stopping to calculate molarities.

The following guides might help:

1/ The equipment list is based on items required by one group.

2/ Any chemical listed with a concentration is a stock solution that must be prepared. In the case of concentrated acids with density and strength corrections the following applies;

Hydrochloric acid, 370g/litre	1Molar = 10%
Sulfuric Acid, 98%, 1.84g/ml density,	1Molar = 5.4%
Nitric Acid, 70%, 1.42g/ml density,	1Molar = 6.3%
Phosphoric acid, 85%, 1.69g/ml density	1Molar = 6.8%
Ethanoic Acid (Glacial Acetic) 99%,	1Molar = 6.6%

3/ Any chemicals without a concentration means simply a class supply.

4/ Please read the risk assessment for your own protection during preparation and DISPOSAL.

5/ I recommend that you photocopy the Teacher Copies and place them in plastic sleeves in a ring folder.

Please feel free to write to me with any suggested improvements and any new experiments would be most welcome.

RISK ASSESSMENT

Every experiment has certain risks, not just from chemicals and equipment but from the unpredictable nature of students. In my years of teaching I have seen some remarkably stupid things such as a student attempting to "snort" citric acid or another trying a sucking contest wth a vacuum cleaner. With this in mind my classification of risk is based on chemical toxicity and exposure (following the new lists), except where the "student factor" seems a greater hazard. Of course professional judgment is needed. Some junior classes can be trusted with delicate equipment while others cannot be trusted with a pair of scissors. However as a general guide:

Low Hazard - Junior Classes

Mild Hazard - Junior classes with close supervision.

Moderate Hazard - Senior classes

HAZARDOUS - Teacher demonstration only.

Remember , familiarity often breeds contempt. Chemicals that are used often may be more toxic than you realise. For example cobalt chloride is a suspected carcinogen with an LD50 of 80mg/kg and and has been deleted from junior experiments in these books. By comparison, copper sulfate, a very commonly used laboratory chemical, has an LD50 of only 300mg/kg. Phenol has the same toxicity yet I am sure you are much more cautious of phenol than you are of copper sulfate. By contrast, lead nitrate is not overly toxic but is dangerous due to its accumulation from repeated small exposures.

PRACTICAL ASSESSMENT SUGGESTIONS

1/ A list of controlled experiments appears in the topic index. Ask your students to identify the appropriate control in each of these experiments.

2/ Collect student work sheets at random and apply a standard marking scale eg. records (4marks), observations (2marks), results (2marks), and conclusion (2marks). This should make the students take practical work seriously, encouraging participation, accurate records and a deductive conclusion (too often neglected).

3/ Record anecdotal marks as the students perform the experiment, focusing on equipment recognition, reading instructions and complete notes.

STUDENT:____________________

101 # Iron Sulfide

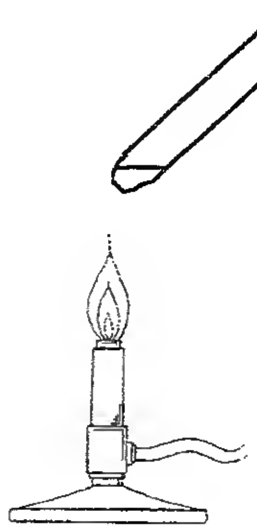
Aim: To produce iron sulfide from its constituent elements.

Equipment

Test Tube
Iron Filings
Sulfur
Bunsen Burner
Spatula
Test Tube Peg

Procedure

1/ Place a spatula of iron filings in a test tube.
2/ Check the magnetic properties of the filings by placing a magnet next to the tube.
3/ Add two spatulas of sulfur and mix.
4/ Heat gently over a Bunsen until a reaction takes place. 5/ 5/ Check the magnetic properties of the compound.
6/ Discard the test tubes.



Results: ____

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Conclusion: ____

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TEACHER COPY

101

Iron Sulfide

Topics: Elements Matter

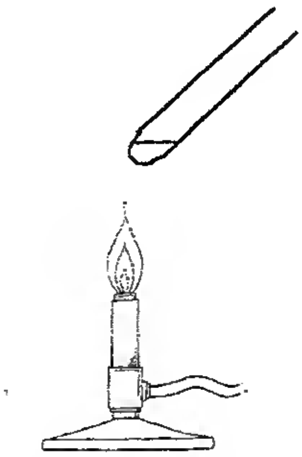
Aim: To produce iron sulfide from its constituent elements.

Equipment

Test Tube
Iron Filings
Sulfur
Bunsen Burner
Spatula
Test Tube Peg

Procedure

Place a spatula of iron filings in a test tube.
Check the magnetic properties of the filings by placing a magnet next to the tube.
Add two spatulas of sulfur and mix.
Heat gently over a Bunsen until a reaction takes place. Check the magnetic properties of the compound.
Discard the test tubes.



Result: A strong reaction takes place forming a new compound which has lost the magnetic attraction originally in the iron filings.

Conclusion: Iron and sulfur react to form Iron Sulfide which has completely different properties to its parent elements. Molecules of Iron and molecules of Sulfur have formed new molecules each containing an atom of Iron and an atom of sulfur.

Risk Level: Mild Hazard: Some fumes may be produced in the reaction and the room should be well ventilated. Ensure the test tubes are dry before performing the experiment.

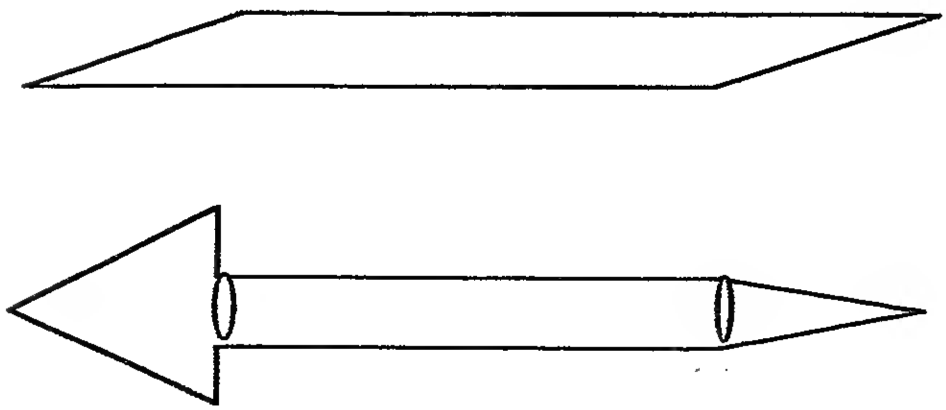
STUDENT:____________________

102 # Kazoo

Aim: To make a simple musical instrument.

Equipment
Sticky tape
Sheet of paper
Scissors

Procedure
1/ Cut a sheet of paper into a 15cm square.
2/ Starting at one corner roll the paper around a pencil.
3/ Sticky tape the edge and remove the pencil.
4/ Make two small cuts at one end, perpendicular to the tube axis, to make a small arrow head.
5/ Suck gently on the opposite end of the tube.



Results: ____

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Conclusion: ____

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TEACHER COPY

Kazoo

Topics: Waves

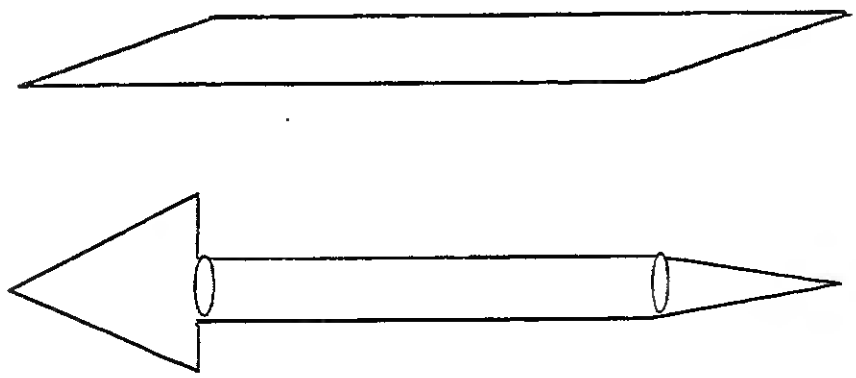
Aim: To make a simple musical instrument.

Equipment

Sticky tape
Sheet of paper
scissors

Procedure

Cut a sheet of paper into a 15cm square.
Starting at one corner roll the paper around a pencil.
Sticky tape the edge and remove the pencil.
Make two small cuts at one end, perpendicular to the tube axis, to make a small arrow head.
Suck gently on the opposite end of the tube.



Result: The arrow head flap vibrates producing a sound

Conclusion: Sound is a vibration

Risk Level: Low Hazard

STUDENT:____________________

103

Ksp

Aim: To empirically measure and calculate the solubility product of a compound.

Equipment

Beaker 250ml
Measuring Cylinder, 100ml
Balance, 0.01g sensitivity
Filter paper,
Bunsen Burner
Tripod
Lead Chloride ($PbCl_2$)

Procedure

Accurately weigh the beaker.
Accurately weigh 5g of lead chloride and add to beaker.
Add 100mls of water and stir for five minutes.
Allow the solution to stand for five minutes.
Carefully decant the solution, retaining the sediment.
Intermittently heat the beaker with a blue Bunsen flame until the sediment is dry.
Reweigh the beaker.
Calculate the mass of lead chloride which dissolved.
Calculate the moles of lead chloride which dissolved.

Calculate the molarity of the lead chloride solution.
Calculate the molarity of the Pb^{2+} and Cl^- ions.
Calculate the solubility product for lead chloride.

Results: ____

____

____

Conclusion: ____

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TEACHER COPY

103 Ksp

Topics: Solubility Molarity

Aim: To empirically measure and calculate the solubility product of a compound.

Equipment

Beaker 250ml
Measuring Cylinder, 100ml
Balance, 0.01g sensitivity
Filter paper,
Bunsen Burner
Tripod
Lead Chloride ($PbCl_2$)

Procedure

Accurately weigh the beaker.
Accurately weigh 5g of Lead chloride and add to beaker.
Add 100mls of water and stir for five minutes.
Allow the solution to stand for five minutes.
Carefully decant the solution, retaining the sediment.
Intermittently heat the beaker with a blue Bunsen flame until the sediment is dry.
Reweigh the beaker.
Calculate the mass of Lead chloride which dissolved.
Calculate the moles of Lead chloride which dissolved.

Calculate the Molarity of the Lead chloride solution.
Calculate the Molarity of the Pb^{2+} and Cl^- ions.
Calculate the solubility product for Lead chloride.

Result: 2 -5 $X10^{-5}$

Conclusion: Lead (II) Chloride is slightly soluable.

Risk Level: Moderate Hazard: Lead chloride is toxic if ingested and lead compounds are a cumulative toxin. The beakers may be cleaned with a nitric acid rinse or scouring with gloves.

STUDENT:____________________

104 Laser Diffraction

Aim: To measure the wavelength of a laser from its interference pattern.

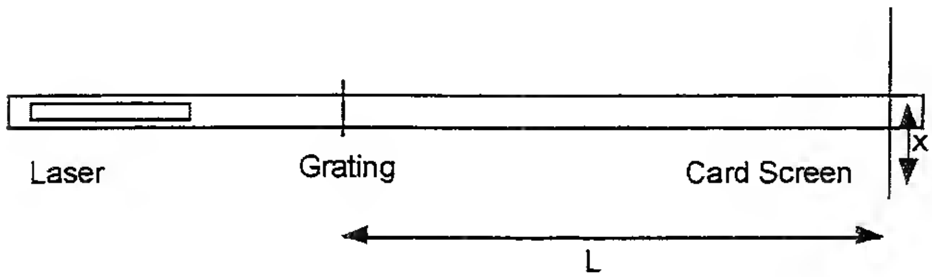
Equipment

Laser pointer
Diffraction grating
white card, 40cm X 10cm
Metre rule

Procedure

Point the laser through a diffraction grating and project the diffraction pattern on the card behind.
Ensure the card and grating are parallel.
Adjust the the distance between the card and grating to display the first and second maxima either side of the central maximum.
Mark the locations of the maxima on the card.
Measure the distance between the grating and the card.

$n\lambda = dx/L$, n = number of maxima, d = slit width (inverse of lines per metre) , L = distance from card to grating,
x = distance of the maxima from the central maxima.
Hint: Use only the first maxima to keep angles small. A correction may be required for the refractive index of glass if the waves must travel through glass after diffraction.



Results: ____

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Conclusion: ____

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104

Laser Diffraction

Topics: Wave Prop Light

Aim: To measure the wavelength of a laser from its interference pattern.

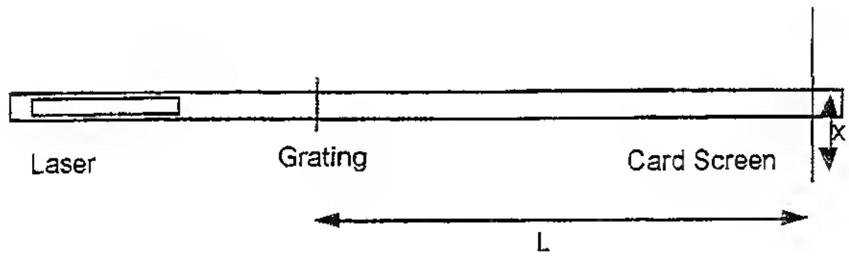
Equipment

Laser pointer
Diffraction grating
white card, 40cm X 10cm
Metre rule

Procedure

Point the laser through a diffraction grating and project the diffraction pattern on the card behind.
Ensure the card and grating are parallel.
Adjust the the distance between the card and grating to display the first and second maxima either side of the central maximum.
Mark the locations of the maxima on the card.
Measure the distance between the grating and the card.

$n\lambda = dx/L$, n = number of maxima, d = slit width (inverse of lines per metre) , L = distance from card to grating, x = distance of the maxima from the central maxima.
Hint: Use only the first maxima to keep angles small. A correction may be required for the refractive index of glass if the waves must travel through glass after diffraction.



Result:

Conclusion: Since diffraction is a phenomenon linked to wavelength then the interference pattern can be used to calculate the wavelength of the source light.

Risk Level: Moderate Hazard: Even small pointing lasers can damage eyesight. The laser must remain in the control of the teacher at all times.

STUDENT:____________________

105 Latent Heat

Aim: To determine the latent heat of fusion for water.

Equipment

Foam Cup
Measuring Cylinder, 100ml
Ice
Thermometer
Warm water

Procedure

Add 75ml of luke warm water to the foam cup.
Record the temperature. _______
Add about a desert spoon of ice.
When the ice has melted, stir with the thermometer and record the temperature. _______
Measure the water volume again.
Calculate the additional volume V2.______
Calculate the Energy needed to cool the original 75ml.
Energy1 = 75 X temp change X 4.18
= 75 X _______ X 4.18 = _______

Calculate the energy needed to heat the ice from zero
Energy2 = V2 X temp change from zero X 4.18
= _____ X _______ X 4.18
Latent Heat of Water = (Energy1 - Energy2)/ V2
= (____ - _____) / _____

= __________ Joules

Results: ____

____

____

Conclusion: ____

____

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105

Latent Heat

Topics: Matter Chemical Energy

Aim: To determine the latent heat of fusion for water.

Equipment

Foam Cup
Measuring Cylinder, 100ml
Ice
Thermometer
Warm water

Procedure

Add 75ml of luke warm water to the foam cup.
Record the temperature. _______
Add about a desert spoon of ice.
When the ice has melted, stir with the thermometer and record the temperature. _______
Measure the water volume again.
Calculate the additional volume V2.______
Calculate the Energy needed to cool the original 75ml.
Energy1 = 75 X temp change X 4.18
= 75 X _______ X 4.18 = _______

Calculate the energy needed to heat the ice from zero
Energy2 = V2 X temp change from zero X 4.18
= _____ X _______ X 4.18
Latent Heat of Water = (Energy1 - Energy2)/ V2
= (____ - _____) / _____

= __________ Joules

Result:

Conclusion: The latent heat of water is 333 J/g . The figure derived in the experiment will be increased by heat losses to the air.

Risk Level: Low Hazard

STUDENT:____________________

106

Latitude

Aim: To determine the latitude of our school.

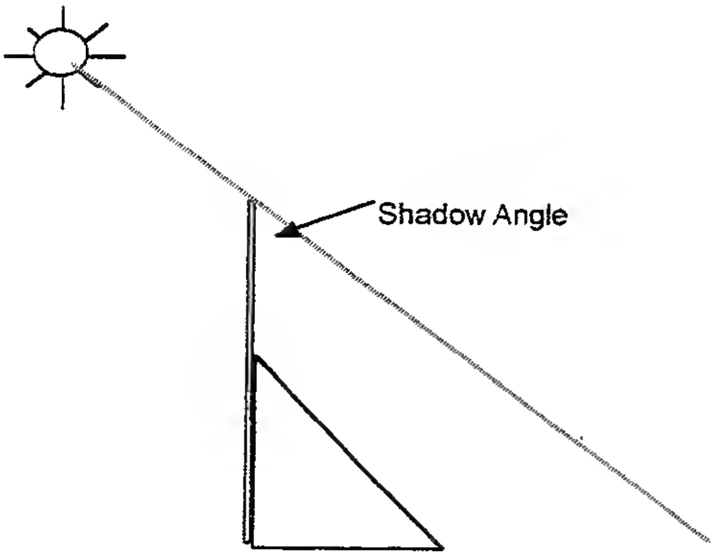
Equipment

Rulers, two
Set square
Calculator
(Juniors need a Protractor and 45 cm ruler)

Procedure

September 22nd or March 22nd or two days either side.
Go outside to a sunny patch of ground just before midday.
Hold one ruler vertically using the set square to ensure it is at a right angle to the ground.
Measure the length of the shadow cast by the ruler.
Latitude of your location will be equal to the inverse Tangent of the ratio of the length of the shadow divided by the length of the ruler.
Use the calculator to find this value.
Check your result with an atlas.

Classes unfamiliar with trigonometry can place the 45cm ruler from the top of the first ruler to the shadow position on the gound. A protractor can now be used to measure the shadow angle.



Results: ____

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Conclusion: ____

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106

Latitude

Topics: The Earth The Sky

Aim: To determine the latitude of our school.

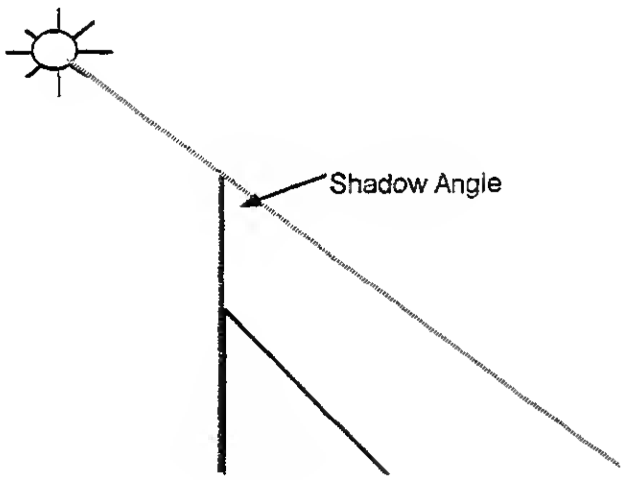
Equipment

Rulers, two
Set square
Calculator
(Juniors need a Protractor and 45 cm ruler)

Procedure

September 22nd or March 22nd or two days either side.
Go outside to a sunny patch of ground just before midday.
Hold one ruler vertically using the set square to ensure it is at a right angle to the ground.
Measure the length of the shadow cast by the ruler.
Latitude of your location will be equal to the inverse Tangent of the ratio of the length of the shadow divided by the length of the ruler.
Use the calculator to find this value.
Check your result with an atlas.

Classes unfamiliar with trigonometry can place the 45cm ruler from the top of the first ruler to the shadow position on the gound. A protractor can now be used to measure the shadow angle.



Result: The latitude by this method is a good approximation.

Conclusion: The angle of the shadow is equal to the latitude since longer shadows must be produced at locations further toward the pole and hence more oblique to the sun. The result at the Summer Solstace would be minus 23.5 degrees and in winter, plus 23.5 degrees, that is the tilt of the Earth.

Risk Level: Low Hazard.

STUDENT:____________________

107

Liquid Air

Aim: To investigate the properties of various materials at very low temperatures.

Equipment

Heat Tile
Heavy gloves
Tongs
Beaker,2L,Pyrex
small flowers
mortar and pestleplastic
milk bottle
Rubber band
Grape or berry

Procedure

1/ What happens to a balloon placed in liquid air?

____

2/ What happens to a rubber band in liqid air?

____

3/ What happens to flowers in liquid air?

____

4/ What happens to carbon dioxide gas in liquid air?

____

5/ What happens to a bottle filled with liquid air?

____

Results: ____________________

____

____

Conclusion: ____________________

____

____

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107

Liquid Air

Topics: Matter The Atmosphere Gas laws

Aim: To investigate the properties of various materials at very low temperatures.

Equipment

Heat Tile
Heavy gloves
Tongs
Beaker,2L,Pyrex
small flowers
mortar and pestleplastic
milk bottle
Rubber band
Grape or berry

Procedure

Obtain a container of liquid nitrogen from CIG or Herd Improvement Services (country centres).
Place the beaker on the heat tile on a low table.
All students must stand well back.
Carefully pour liquid nitrogen into the beaker.

1. Rest an inflated balloon in the beaker: it will shrink and collapse, then reinflate when withdrawn.
2. Place a rubber band into the liquid. Use tongs to withdraw when frozen: the rubber is now brittle.
3. Immerse the flowers .Withdraw the flowers and place in the pestle: the flowers are now brittle and will grind to dust.
4. Generate carbon dioxide in a separate flask using acid and carbonate. Bubble the gas into the liquid nitrogen via a tube: Dry Ice will be formed.
5. Take the students out side. Pour some liquid nitrogen into the plastic bottle and screw on the cap. Stand well clear and wait. Strike with a broom handle if nothing happens after 2 minutes.

Result: Liquid Nitrogen has a boiling point of 196 degrees centigrade below zero. Most substances become solid and brittle at this temperature.

Conclusion: Liquid nitrogen has a temperature close to absolute zero (zero Kelvin, -273 Celcius). At these temperatures molecular vibration is minimal and most substances are solid regardless of whether there are significant inter-molecular forces.

Risk Level: HAZARDOUS: TO BE PERFORMED ONLY BY A TEACHER Liquid nitrogen easily freezes tissue on contact. Do not touch the beaker or any frozen objects.

STUDENT:________________

108 Liquid Diffusion

Aim: To observe diffusion in liquids.

Equipment
Beaker, 1 litre (filled with water before the lesson)
Potassium Permanganate

Procedure
Drop a few crystals of potassium permanganate into the beaker at the start of the lesson and leave the beaker undisturbed.

Results: ____

____

____

Conclusion: ____

____

____

TEACHER COPY

108

Liquid Diffusion

Topics: Matter Kinetic Theory States of Matter

Aim: To observe diffusion in liquids.

Equipment

Beaker, 1 litre (filled with water before the lesson)
Potassium Permanganate

Procedure

Drop a few crystals of potassium permanganate into the beaker at the start of the lesson and leave the beaker undisturbed.

Result: The purple crystals dissolved and the colour gradually spread throughout the liquid without stirring.

Conclusion: The purple permanganate ions spread throughout the water by diffusion ie. the random jostling and movement of molecules in a liquid.

Risk Level: Low Hazard: Potassium Permanganate is harmful if ingested and stains skin.

STUDENT:____________________

109 Living Fire

Aim: To examine the characteristics of living things.

Equipment

Bunsen
Potted plant
Rock
Jiffy Pot (peat moss disk)
Dissecting Microscope

Procedure

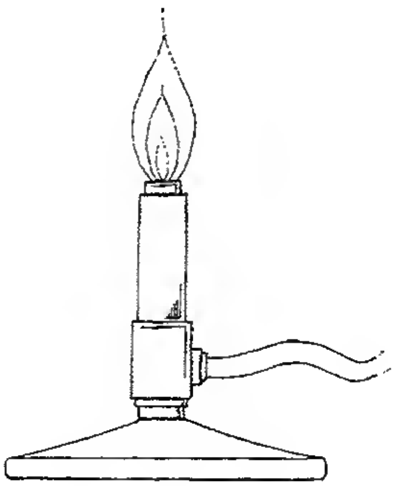
In what ways does a flame resemble a living thing?

1.____________________

2.____________________

3.____________________

4.____________________



Results: ____________________

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Conclusion: ____________________

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109

Living Fire

Topics: Living Things

Aim: To examine the characteristics of living things.

Equipment

Bunsen
Potted plant
Rock
Jiffy Pot (peat moss disk)
Dissecting Microscope

Procedure

Light a Bunsen.
Add water to jiffy pot.
Start your class on a discussion of the characteristics of living things.
Jiffy Pot: grows, (assimilates)
Bunsen: assimilates, responds (block adjusting vent), can grow, can reproduce.

Result:

Conclusion: A flame has all the general characteristics of a living thing however it lacks a cellular structure. All living things have a cellular structure.

Risk Level: Low Hazard

STUDENT:____________________

110 Long Springs

Aim: To observe different types of waves.

Equipment

Spring 3m length
piece of paper, 3cm X 1cm
Sticky tape

Procedure

Tape the piece of paper like a flag to a coil in the middle of the spring.
Extend the spring over several abutted tables.
Send a compression wave down the spring by compressing and releasing some coils at one end.
Note the movement of the paper flag.
Note any reflections.
Send a transverse wave down the spring by giving the end a sharp wiggle.
Note the movement of the paper flag.

Send a torsional wave down the spring by twisting and releasing several coils at one end.
Note the movement of the paper flag.

Results: ____

____

____

Conclusion: ____

____

____

TEACHER COPY

110

Long Springs

Topics: Waves

Aim: To observe different types of waves.

Equipment

Spring 3m length
piece of paper, 3cm X 1cm
Sticky tape

Procedure

Tape the piece of paper like a flag to a coil in the middle of the spring.
Extend the spring over several abutted tables.
Send a compression wave down the spring by compressing and releasing some coils at one end.
Note the movement of the paper flag.
Note any reflections.
Send a transverse wave down the spring by giving the end a sharp wiggle.
Note the movement of the paper flag.

Send a torsional wave down the spring by twisting and releasing several coils at one end.
Note the movement of the paper flag.

Result: Three types of waves are possible. In each case the flag oscillates around a point, firstly back and forth, secondly side to side and lastly arcing side to side.

Conclusion: While the wave moves the whole length of the spring and may reflect several times, individual points move only slightly around a fixed point, that is, energy travels in the wave not matter.

Risk Level: Low Hazard.

STUDENT:____________________

111 Magic Filtration

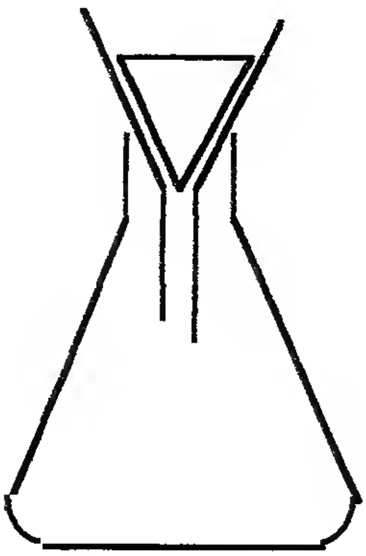
Aim: To observe an unusual ionic change.

Equipment

Potassium Permanganate
Sodium Hydroxide
Beaker, 100ml
Filter Funnel
Filter paper
Conical flask
Measuring Cylinder, 100ml

Procedure

Dissolve 1g of sodium hydroxide in 50ml of water in the beaker.
Add a crystal of potassium permanganate and dissolve.
Pour the red solution through a filter paper into the conical flask.



Results: ____

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Conclusion: ____

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111

Magic Filtration

Topics: Matter Ions

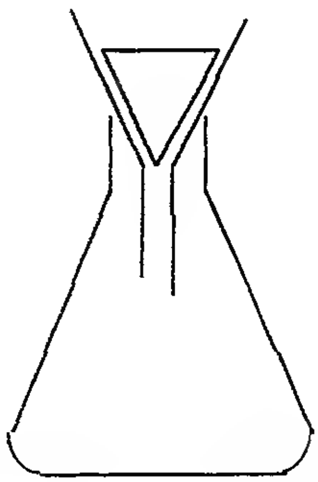
Aim: To observe an unusual ionic change.

Equipment

Potassium Permanganate
Sodium Hydroxide
Beaker, 100ml
Filter Funnel
Filter paper
Conical flask
Measuring Cylinder, 100ml

Procedure

Dissolve 1g of sodium hydroxide in 50ml of water in the beaker.
Add a crystal of potassium permanganate and dissolve.
Pour the red solution through a filter paper into the conical flask.



Result: The purple solution comes through the filter as green.

Conclusion: Potassium permanganate is changed to potassium manganate. This reduction of the permanganate ion is responsible for the colour change, the reducing agent being cellulose in the filter paper.

Risk Level: Mild Hazard: Sodium hydroxide is caustic and any skin contact with the crystals or solution should be treated with immediate and prolonged washing in water.

STUDENT:____________________

112 Making Clouds

Aim: To demonstrate that cloud vapours may be produced by a rapid temperature drop associated with sudden depressurisation.

Equipment

Plastic drink bottle, PET
Bicycle Pump
Tyre valve (squat, tubeless, truck type from tyre centre)

Procedure

Pour a splash of water into the bottle.
Force the tyre valve into the neck and connect the pump.
Pump thirty strokes.
Shake the bottle vigorously.
Prize out the tyre valve.

Draw the apparatus.

Results: ____

____

____

Conclusion: ____

____

____

TEACHER COPY
112

Making Clouds

Topics: Density/Pressure Weather Gas Laws

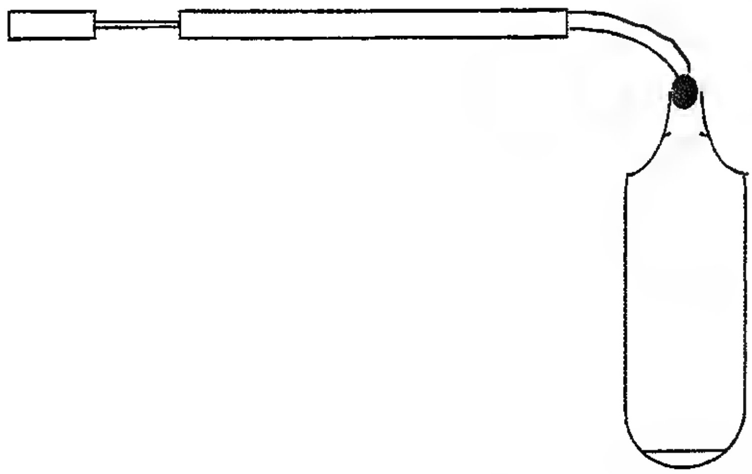
Aim: To demonstrate that cloud vapours may be produced by a rapid temperature drop associated with sudden depressurisation.

Equipment

Plastic drink bottle, PET
Bicycle Pump
Tyre valve (squat, tubeless, truck type from tyre centre)

Procedure

Pour a splash of water into the bottle.
Force the tyre valve into the neck and connect the pump.
Pump thirty strokes.
Shake the bottle vigorously.
Prize out the tyre valve.



Result: The valve releases with a bang and the bottle instantly fills with white swirling vapours.

Conclusion: After shaking, the air in the bottle is saturated with water vapour. Releasing the tyre valve causes sudden depressurisation which results in an instant drop in temperature ($PV = nRT$) and so the vapour condenses into cloud like water droplets.

Risk Level: Low Hazard

STUDENT:________________

113 Making Rocks

Aim: To simulate sedimentary rock formation.

Equipment

Alfoil , 15 X 15cm, 3
dry clay
dry sand
coarse sand
small pebbles
Plaster of Paris
plastic teaspoons
small shells

Procedure

Mix the dry ingredients on alfoil squares, then add the water, mixing until uniformly moist. Form into a shape within the alfoil and then leave open to dry for 2 or 3 days:

SHALE -
5 teaspoons clay.
1/2 teaspoon sand.
1/2 teaspoon paster of Paris.
2 teaspoons of water.

SANDSTONE -
4 teaspoons coarse sand.
1/2 teaspoon dry clay.
1/2 teaspoon plaster of Paris.
2 teaspoons of water.

CONGLOMERATE -
4 teaspoons pebbles1/2 teaspoon dry clay.
1/2 teaspoon plaster of Paris.
1 teaspoon coarse sand.
2 teaspoons of water.
Note : Fossils may be simulated by using a shell to make an impression in the "Shale" mix.

Results: ____

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Conclusion: ____

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113

Making Rocks

Topics: Sedimentary Rocks   Rocks and Minerals   Life in the Past

Aim: To simulate sedimentary rock formation.

Equipment

Alfoil , 15 X 15cm, 3
dry clay
dry sand
coarse sand
small pebbles
Plaster of Paris
plastic teaspoons
small shells

Procedure

Mix the dry ingredients on alfoil squares, then add the water, mixing until uniformly moist. Form into a shape within the alfoil and then leave open to dry for 2 or 3 days:

SHALE -
5 teaspoons clay.
1/2 teaspoon sand.
1/2 teaspoon paster of Paris.
2 teaspoons of water.

SANDSTONE -
4 teaspoons coarse sand.
1/2 teaspoon dry clay.
1/2 teaspoon plaster of Paris.
2 teaspoons of water.

CONGLOMERATE -
4 teaspoons pebbles1/2 teaspoon dry clay.
1/2 teaspoon plaster of Paris.
1 teaspoon coarse sand.
2 teaspoons of water.
Note : Fossils may be simulated by using a shell to make an impression in the "Shale" mix.

Result: The mixtures dry to rock like substances.

Conclusion: Sedimentary rocks are formed from a mixture of eroded particles and fine sediment which has dried.

Risk Level: Low Hazard

STUDENT:____________________

114 Mass of Air 1

Aim: To determine that air has weight.

Equipment

Party balloons, two
Moments ruler
Capstan block
retort stand
string, two 20cm lengths
pencil

Procedure

Loosely tie a loop of string around the neck of each deflated balloon.
Balance the balloons on a moments ruler mounted via a capstan block on a retort stand.
Mark the positions of each balloon with a pencil.
Inflate one balloon.
Reposition both balloons on the moments ruler.

Results: ____________________

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Conclusion: ____________________

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114

Mass of Air 1

Topics: Density/Pressure Air

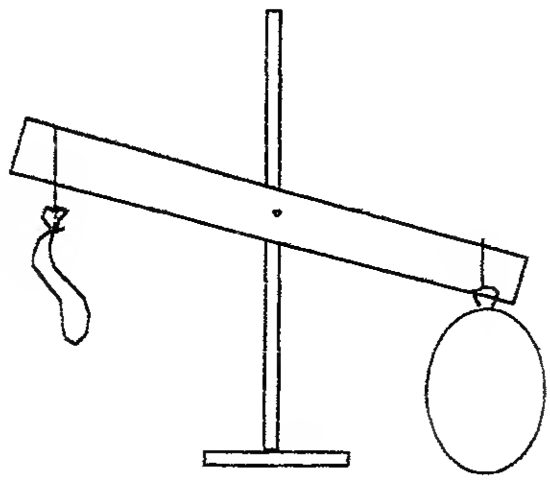
Aim: To determine that air has weight.

Equipment

Party balloons, two
Moments ruler
Capstan block
retort stand
string, two 20cm lengths
pencil

Procedure

Loosely tie a loop of string around the neck of each deflated balloon.
Balance the balloons on a moments ruler mounted via a capstan block on a retort stand.
Mark the positions of each balloon with a pencil.
Inflate one balloon.
Reposition both balloons on the moments ruler.
The uninflated balloon is a "control".



Result: The inflated balloon is heavier than the deflated balloon.

Conclusion: Air has weight (approximately 1.2g per litre resulting in a pressure of about 1kg per square centimetre).

Risk Level: Low Hazard

STUDENT:____________________

115

Mass of Air 2

Aim: To determine the mass of a litre of air.

Equipment

Round Bottom flask, 500ml
Rubber Stopper
Bunsen
Retort stand and clamp
Balance, 0.1g accuracy
Measuring cylinder, 500ml
Measuring cylinder, 100ml

Procedure

Completely fill the round bottom flask with water.
Fit the rubber stopper.
Remove the stopper and measure the volume of water with the large measuring cylinder (V1)._______
Add about 50mls of water back to the flask.
Support the flask on the retort stand and heat with a Bunsen until the water is boiling vigorously.
Turn off the Bunsen and immediately fit the stopper in the flask.
Weigh the flask accurately (M1)._____

Remove the stopper to allow air to rush in.
Replace the stopper and weigh again (M2).______
Pour out the remaining water into the small measuring cylinder (V2)._______

$$\text{Mass of one litre of air} = \frac{M2 - M1}{V1 - V2 \text{ (in litres)}}$$

=

Results: ____

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Conclusion: ____

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115

Mass of Air 2

Topics: Density/Pressure Air

Aim: To determine the mass of a litre of air.

Equipment

Round Bottom flask, 500ml
Rubber Stopper
Bunsen
Retort stand and clamp
Balance, 0.1g accuracy
Measuring cylinder, 500ml
Measuring cylinder, 100ml

Procedure

Completely fill the round bottom flask with water.
Fit the rubber stopper.
Remove the stopper and measure the volume of water with the large measuring cylinder (V1).________
Add about 50mls of water back to the flask.
Support the flask on the retort stand and heat with a Bunsen until the water is boiling vigorously.
Turn off the Bunsen and immediately fit the stopper in the flask.
Weigh the flask accurately (M1) "Control Measurement"._____

Remove the stopper to allow air to rush in.
Replace the stopper and weigh again (M2)._____
Pour out the remaining water into the small measuring cylinder (V2)._______

$$\text{Mass of one litre of air} = \frac{M2 - M1}{V1 - V2 \text{ (in litres)}}$$

$=$

Result: The flask weighed more when the stopper was released.

Conclusion: Air has a mass of about 1.2 gm litre which yields a pressure of about 1kg per square centimetre at sea level.

Risk Level: Moderate Hazard: Only good quality round bottom flasks should be used as there is a possibility of the flask imploding.

STUDENT:________________

116 Measuring Clouds

Aim: To measure the distance and size of a cloud using parallax.

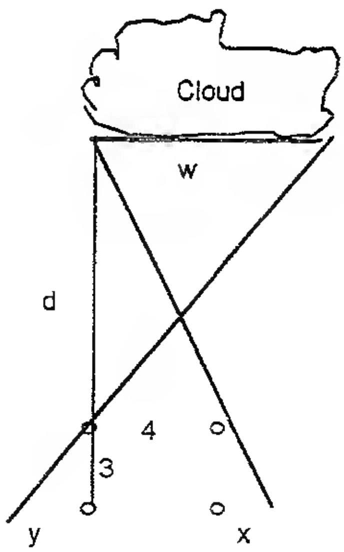
Equipment

Tape measure (5m)
4 Tomato stakes
spirit level
2 rulers
Hammer
calculator

Procedure

Take the class to the school oval.
Hammer two tomato stakes in the ground 4m apart.
Hammer two more stakes 3m behind the others, checking the diagonal in each case is 5m.
Use the spirit level to straighten the stakes.
Two students each with a ruler stand behind the second pair of stakes .

When the edge of a cloud is in line with the first observer, the second observer measures the parallax to that point, meanwhile the first observer measures the parallax to the opposite edge of the cloud.



$d = 12/x$

$w = dy/3$

Results: ______________________________

____

____

Conclusion: ______________________________

____

____

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116

Measuring Clouds

Topics: Weather

Aim: To measure the distance and size of a cloud using parallax.

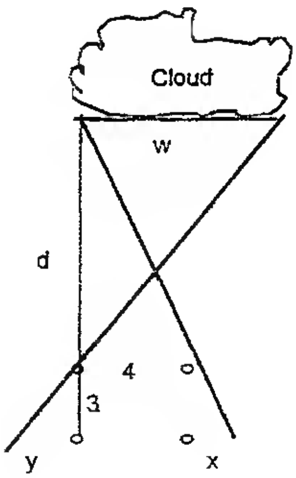
Equipment

Tape measure (5m)
4 Tomato stakes
spirit level
2 rulers
Hammer
calculator

Procedure

Take the class to the school oval.
Hammer two tomato stakes in the ground 4m apart.
Hammer two more stakes 3m behind the others, checking the diagonal in each case is 5m.
Use the spirit level to straighten the stakes.
Two students each with a ruler stand behind the second pair of stakes .

When the edge of a cloud is in line with the first observer, the second observer measures the parallax to that point, meanwhile the first observer measures the parallax to the opposite edge of the cloud.



$d = 12/x$

$w = dy/3$

Result: Clouds are typically 3 to 10 kilometre distant and several kilometre across.

Conclusion: Parallax is a useful technique for measuring distant objects provided the distance between the two observers is not too small relative to the distance of the object.

Risk Level: Low Hazard

STUDENT:____________________

117 Measuring the Earth

Aim: To use the Internet to calculate the circumference of the Earth.

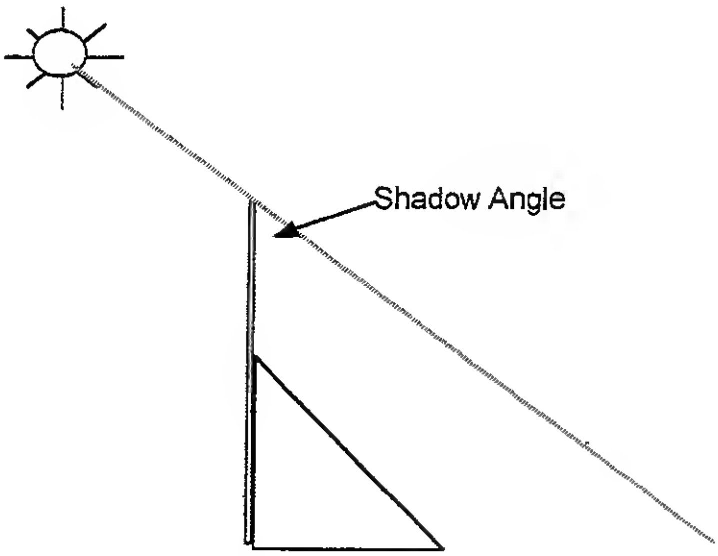
Equipment

Atlas
Internet Computer
rulers, 2
set square
calculator

Procedure

Use an Atlas to locate some towns several hundred kilometres directly north or south of your location.
Contact a school in one of these towns on the Internet.
Arrange to simultaneously perform the following experiment at a given date and time.
On a horizontal surface in the sunlight hold one ruler vertical using the set square. With another ruler measure the length of the shadow.
Shadow Angle = $\tan^{-1}$(shadow length / ruler length)

Use the atlas to determine the distance between the two locations.
Earths circumference
= distance X 360 / difference in shadow angles



Results: ____

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Conclusion: ____

____

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117

Measuring the Earth

Topics: The Earth

Aim: To use the Internet to calculate the circumference of the Earth.

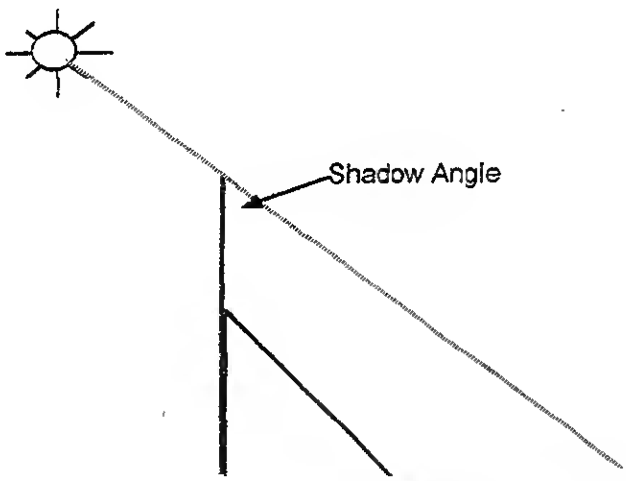
Equipment

Atlas
Internet Computer
rulers, 2
set square
calculator

Procedure

Use an Atlas to locate some towns several hundred kilometres directly north or south of your location.
Contact a school in one of these towns on the Internet.
Arrange to simultaneously perform the following experiment at a given date and time.
On a horizontal surface in the sunlight hold one ruler vertical using the set square. With another ruler measure the length of the shadow.
Shadow Angle = Tan^{-1}(shadow length / ruler length)

Use the atlas to determine the distance between the two locations.
Earths circumference
= distance X 360 / difference in shadow angles



Result: Should yield answers close to 40000 kilometres if measurements are accurate, the surface level and the shadow stick is vertical.

Conclusion: This calculation was first performed by a Greek scholar in Egypt over 2000 years ago. His calculation was surprisingly accurate considering he could not use the Internet to be in two places simultaneously. He had heard of a well far to the south where the sun reached the bottom only on one day of the year. From camel caravanners he learnt the distance in camel strides.

Risk Level: Low Hazard.

STUDENT:____________________

118 Metho and Water

Aim: To investigate the particle nature of matter.

Equipment

Measuring Cylinder, 100ml
Beaker, 100ml
Methylated Spirits

Procedure

Measure 50ml of water into the beaker.
Measure 50ml of Methylated Spirits and add it to the water.
Measure the volume of the mixture.

Results: ____

____

____

Conclusion: ____

____

____

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118

Metho and Water

Topics: Matter Atoms & Molecules

Aim: To investigate the particle nature of matter.

Equipment

Measuring Cylinder, 100ml
Beaker, 100ml
Methylated Spirits

Procedure

Measure 50ml of water into the beaker.
Measure 50ml of Methylated Spirits and add it to the water.
Measure the volume of the mixture.
Adding water to water would be a "control".

Result: The combined volume is less than 100mls.

Conclusion: Both water and methylated spirits are composed of tiny molecules with spaces in between. When mixed, some of the smaller water molecules can fit in the spaces between methylated spirits molecules and so the total volume is smaller.

Risk Level: Very Low Hazard: Methylated spirits is flammable and all Bunsens should be off.

STUDENT:________________

119 Metho Rockets

Aim: To demonstrate an explosive chemical reaction which is the principle behind rocket fuel.

Equipment

Clip top plastic drink bottle
eg chocolate milk
Methylated spirits
Dissecting Needle
Power supply 0-12V,DC
Induction Coil
Connecting wires
Retort Stand, boss, clamp

Procedure

Draw the apparatus used by the teacher.

Results: ________________________________

____

____

Conclusion: ________________________________

____

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119

Metho Rockets

Topics: Chemical reactions Solar System Chemical Energy

Aim: To demonstrate an explosive chemical reaction which is the principle behind rocket fuel.

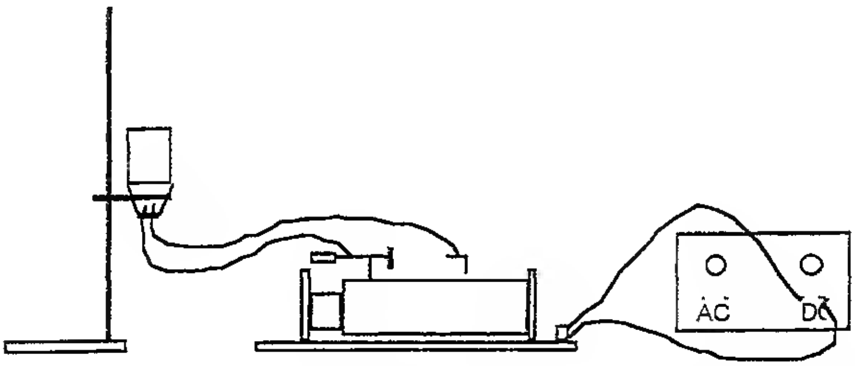
Equipment

Clip top plastic drink bottle eg chocolate milk
Methylated spirits
Dissecting Needle
Power supply 0-12V,DC
Induction Coil
Connecting wires
Retort Stand, boss, clamp

Procedure

Use the dissecting needle to force two holes, 2cm apart, through the lid of the plastic bottle.
Force two insulated wires through the holes.
Connect the wires to the electrodes of the Induction coil
Connect the power supply to the coil and check that sparks will jump between the wires in the lid.
Set up the retort stand and clamp so it will loosely cradle the plastic bottle, vertical and inverted.
Pour a few millilitres of Methanol into the plastic bottle.
Swirl the liquid then pour out into a sink.

Clip on the lid with ignition wires.
Cradle the bottle (inverted) in the prepared retort clamp.
Lights off .
Power on.
Bang.



Result: With a loud bang and flash of flame the bottle jumps toward the ceiling.

Conclusion: Vapours of methylated spirits form an explosive mixture with air. The heat of the reaction causes rapid expansion of air in the bottle, blasting the lid away. The escaping air causes an equal and opposite reaction on the bottle, thrusting it upwards.

Risk Level: HAZARDOUS: TEACHER DEMONSTRATION ONLY. Methylated spirits is highly flammable. Residues on the lid may ignite the plastic. Do not use screw top bottles or glass bottles.

STUDENT:__________________

120

Microbes 2

Aim: To observe unicellular organisms such as algae, Protozoa, amoeba, and bacteria.

Equipment

Fish pond or hay infusion (grass in water , 6 weeks)
Centrifuge Tubes
Pasteur Pipettes
Centrifuge
Microscope slides
Coverslips.

Procedure

Collect two centrifuge tubes full of fish pond sediment or hay infusion water.
Balance the tubes and spin in a centrifuge for 10 mins at 1000rpm.
Discard the supernatant.
Resuspend the bottom pellet in a few drops of supernatant by flicking the tube base.
Draw up the suspended pellet in a Pasteur pipette
Apply one small drop to each microscope slide
Examine under a microscope at 400X.

Draw some of the organisms you see.

Results: ____

____

____

Conclusion: ____

____

____

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120

Microbes 2

Topics: Cells Microbes & Immunity

Aim: To observe unicellular organisms such as algae, Protozoa, amoeba, and bacteria.

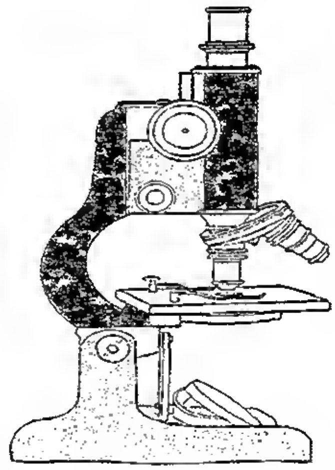
Equipment

Fish pond or hay infusion (grass in water , 6 weeks)
Centrifuge Tubes
Pasteur Pipettes
Centrifuge
Microscope slides
Coverslips.

Procedure

Collect two centrifuge tubes full of fish pond sediment or hay infusion water.
Balance the tubes and spin in a centrifuge for 10 mins at 1000rpm.
Discard the supernatant.
Resuspend the bottom pellet in a few drops of supernatant by flicking the tube base.
Draw up the suspended pellet in a Pasteur pipette
Apply one small drop to each microscope slide
Examine under a microscope at 400X.

Draw some of the organisms you see.



Result:

Conclusion: A wide range of algae, protozoans, amoeba, rotifiers and algae should be visible. Bacteria will just be visible as rods and motile spirochettes.

Risk Level: Low Hazard. ONLY THE TEACHER SHOULD OPERATE THE CENTRIFUGE.

STUDENT:________________

121 Molar Volume

Aim: To measure the molar volume of hydrogen gas.

Equipment

Magnesium Ribbon, 5cm
Steel wool
Hydrochloric Acid 3M, 30%
Balance, 0.01g accuracy
Measuring Cylender, 50ml
Stopper to fit cylinder
Copper wire, 10cm
Beaker, 1 litre
Retort stand and clamp

Procedure

Clean the Magnesium Ribbon with steel wool.
Accurately weigh the ribbon.
Use the copper wire to tie the magnesium ribbon and attach it to the inner end of the stopper.
Add 15ml of the acid to the measuring cylinder.
Carefully add water down the side of the cylinder so as not to disturb the acid layer.
Continue until the cylinder is full.
Add 400ml of water to the beaker.
Insert the stopper with ribbon, in the measuring cylinder.

Invert the cylinder into the beaker and support it just free of the bottom with the retort stand.
Ensure the stopper has fallen loose.
When the ribbon is fully reacted add water to the beaker until water levels inside and outside the cylinder are equal.
Record the gas volume in the cylinder.
Calculate the moles of Magnesium used.
Write an equation for the reaction.
Calculate the moles of hydrogen produced.
Calculate the Volume of hydrogen at STP using:
PV/ T =PV/T
Calculate the volume 1 mole of hydrogen would occupy.

Results: ____

____

____

Conclusion: ____

____

____

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121

Molar Volume

Topics: Molarity Gas Laws

Aim: To measure the molar volume of hydrogen gas.

Equipment

Magnesium Ribbon, 5cm
Steel wool
Hydrochloric Acid 3M, 30%
Balance, 0.01g accuracy
Measuring Cylender, 50ml
Stopper to fit cylinder
Copper wire, 10cm
Beaker, 1 litre
Retort stand and clamp

Procedure

Clean the Magnesium Ribbon with steel wool.
Accurately weigh the ribbon.
Use the copper wire to tie the magnesium ribbon and attach it to the inner end of the stopper.
Add 15ml of the acid to the measuring cylinder.
Carefully add water down the side of the cylinder so as not to disturb the acid layer.
Continue until the cylinder is full.
Add 400ml of water to the beaker.
Insert the stopper with ribbon, in the measuring cylinder.

Invert the cylinder into the beaker and support it just free of the bottom with the retort stand.
Ensure the stopper has fallen loose.
When the ribbon is fully reacted add water to the beaker until water levels inside and outside the cylinder are equal.
Record the gas volume in the cylinder.
Calculate the moles of Magnesium used.
Write an equation for the reaction.
Calculate the moles of hydrogen produced.
Calculate the Volume of hydrogen at STP using:
$PV/T = PV/T$
Calculate the volume 1 mole of hydrogen would occupy.

Result:

Conclusion: The molar Volume at STP is 22.4 litres. Note: Solubility of hydrogen gas in water is 0.00015g/ 100ml.

Risk Level: Moderate Risk: Hydrochloric acid 3M is highly corrosive and any skin contact should be treated with vigorous washing.

STUDENT:____________________

122

Molecular Bonds

Aim: To observe and compare the stability of Covalent and Ionic compounds when heated.

Equipment

Lead Carbonate,
Copper Carbonate,
Sodium Chloride
Calcium Chloride
Crucible,
Pipe clay Triangle
Tripod and Bunsen
Tongs

Procedure

Place a spatula of white lead carbonate into a crucible.
Heat on a tripod fitted with a pipe clay triangle.
Continue heating for five minutes.
Record any changes in the compound.
Use tongs to empty the crucible into the dry waste container.
Repeat the experiment each of the other compounds.

Compound	Changes due to heating

Results: ____

____

____

Conclusion: ____

____

____

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122

Molecular Bonds

Topics: Chemical Reactions Elements How atoms join

Aim: To observe and compare the stability of Covalent and Ionic compounds when heated.

Equipment

Lead Carbonate,
Copper Carbonate,
Sodium Chloride
Calcium Chloride
Crucible,
Pipe clay Triangle
Tripod and Bunsen
Tongs

Procedure

Place a spatula of white lead carbonate into a crucible.
Heat on a tripod fitted with a pipe clay triangle.
Continue heating for five minutes.
Record any changes in the compound.
Use tongs to empty the crucible into the dry waste container.
Repeat the experiment each of the other compounds.

Result: The white lead carbonate changed to a yellow powder, then red and finally small beads of metal appeared. Copper carbonate becomes black copper Oxide. Sodium chloride and calciuim chloride showed no changes.

Conclusion: Covalent Lead carbonate is broken down by heat into allotropes of lead oxide and further heating produces lead. Covalent copper carbonate breaks down to black copper Oxide. Sodium chloride, and calciuim chloride are Ionic salts was totally resistant to Bunsen heat since the ionic bonds within the molecule are very strong.

Risk Level: Moderately hazardous: Fumes may be produced during heating and this experiment should be performed with limited quantities in a well ventilated room. Asthmatics should be excused.

STUDENT:________________

123

Molecular Weight

Aim: To determine the Molecular Weight of Butane gas.

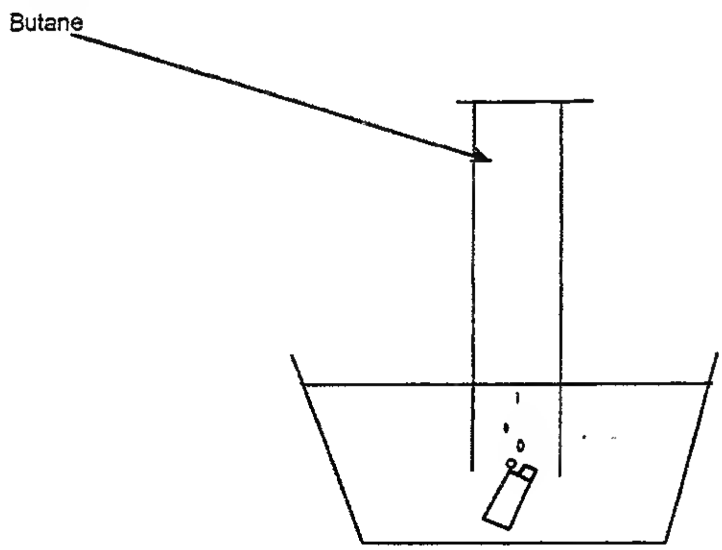
Equipment

Measuring Cylinder, 250ml
Plastic tray, large
retort stand, clamps, two
Butane Lighter
Electronic Balance
Thermometer
Barometer

Procedure

Fill the plastic tray with water.
Fill the measuring cylinder with water and lay it in the trough.
Place the retort stand in the trough and support the measuring cylinder in an inverted position.
Record the temperature and pressure in the room.
Accurately weigh the butane lighter.
Place the lighter beneath the measuring cylinder releasing the valve so that gas bubbles into the cylinder.
Continue until internal and external water levels are equal.
Record the volume as marked on the cylinder.

Carefully dry the butane lighter and weigh again.
Calculate the mass of Butane gas released.
Calculate the partial pressure of butane by subtracting the vapour pressure of water from the measured air pressure.
Calculate the volume of the Butane at STP.
Calculate this volume as a fraction of the Molar Volume.
Use this fraction to multiply the mass of the Butane.
Final answer should closely approximate the Molecular Wt.



Results: ____

____

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Conclusion: ____

____

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123

Molecular Weight

Topics: Mole Concept

Aim: To determine the Molecular Weight of Butane gas.

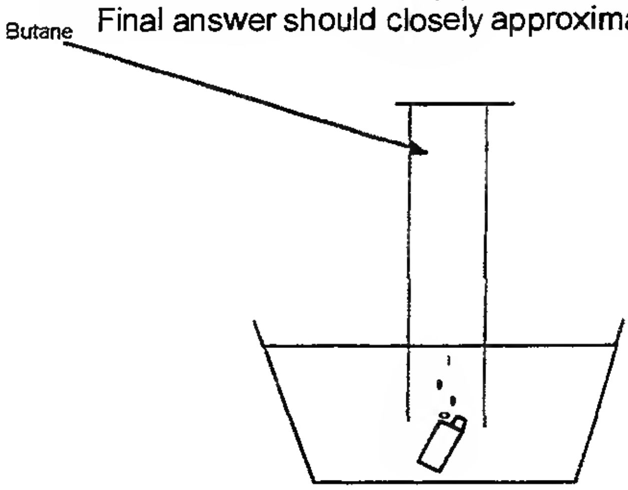
Equipment

Measuring Cylinder, 250ml
Plastic tray, large
retort stand, clamps, two
Butane Lighter
Electronic Balance
Thermometer
Barometer

Procedure

Fill the plastic tray with water.
Fill the measuring cylinder with water and lay it in the trough.
Place the retort stand in the trough and support the measuring cylinder in an inverted position.
Record the temperature and pressure in the room.
Accurately weigh the butane lighter.
Place the lighter beneath the measuring cylinder releasing the valve so that gas bubbles into the cylinder.
Continue until internal and external water levels are equal.
Record the volume as marked on the cylinder.

Carefully dry the butane lighter and weigh again.
Calculate the mass of Butane gas released.
Calculate the partial pressure of butane by subtracting the vapour pressure of water from the measured air pressure.
Calculate the volume of the Butane at STP.
Calculate this volume as a fraction of the Molar Volume.
Use this fraction to multiply the mass of the Butane.
Final answer should closely approximate the Molecular Wt.



Result:

Conclusion: Butane has a molecular weight of 58.1
Notes: Vapour pressure of water in Pascals : 10 degrees = 1228, 15 degrees =1705, 20 degrees = 2338, 25 degrees = 3167.
Butane has only a small solubility in water.

Risk Level: Low Hazard

STUDENT:___________________

124

Moments

Aim: To investigate the theory of Moments and mechanical advantage in a first order lever.

Equipment

Moments Ruler
Capstan Block
Retort stand
String, 15cm and 40cm
Mass Carrier
Masses, 50g, 4
Weight, 250g

Procedure

Place the capstan block on the retort stand.
Balance the moments ruler on the capstan pivot.
Tie the long string to 250g weight and a loop in the other end of the string.
Slide the loop onto the ruler and adjust the capstan so the string is taught when the ruler is level.
Tie the short string into a loop which slides on the opposite side of the ruler and supports the mass carrier.
Draw up a table with the headings: Mass, Distance from Pivot, Mass X distance, Weight, Distance from Pivot,

Weight X distance.
Slide the weight string to 5cm from the pivot.
Record the mass needed to lift the weight at the same distance from the pivot.
Record the mass needed at 10cm from the pivot.
Record the mass needed at 20cm from the pivot.
Adjust the mass to 100gms and record the distance from the pivot at which it just lifts the weight.

Mass	Distance	Mass X Dist	Weight	Distance	Weight X Dist

Results: ____

____

____

Conclusion: ____

____

____

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124

Moments

Topics: Forces Machines

Aim: To investigate the theory of Moments and mechanical advantage in a first order lever.

Equipment

Moments Ruler
Capstan Block
Retort stand
String, 15cm and 40cm
Mass Carrier
Masses, 50g, 4
Weight, 250g

Procedure

Place the capstan block on the retort stand.
Balance the moments ruler on the capstan pivot.
Tie the long string to 250g weight and a loop in the other end of the string.
Slide the loop onto the ruler and adjust the capstan so the string is taught when the ruler is level.
Tie the short string into a loop which slides on the opposite side of the ruler and supports the mass carrier.
Draw up a table with the headings: Mass, Distance from Pivot, Mass X distance, Weight, Distance from Pivot,

Weight X distance.
Slide the weight string to 5cm from the pivot.
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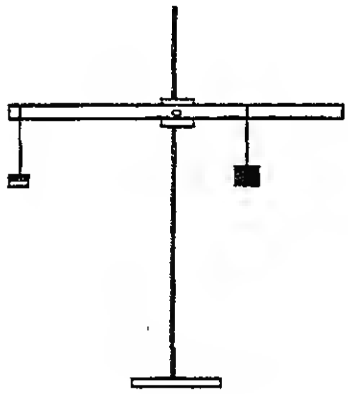
Record the mass needed at 10cm from the pivot.
Record the mass needed at 20cm from the pivot.
Adjust the mass to 100gms and record the distance from the pivot at which it just lifts the weight.



Result: Mass X Distance and Weight X Distance are always equal.

Conclusion: If the distance to the pivot on the effort side is twice the distance on the load side then only half the effort is required, that is, the mechanical advantage (Load/Effort) is “2”.

Risk Level: Low Hazard

STUDENT:________________

125 Morse Code

Aim: To produce a simple Morse code sender and practice "SOS TITANIC"

Equipment

tapping key
Ticker Timer, or lamp
Power supply, 6V AC
connecting leads, 3

Procedure

Connect the tapping key and ticker timer in a series circuit with the power supply, 6V AC.
The Ticker timer will act as a buzzer
Use the tapping key and the code below to send the message.

A	**B**	**C**	**D**	**E**	
._	_...	_._.	_..	.	
F	**G**	**H**	**I**	**J**	
.._.	__.	....	..	.___	
K	**L**	**M**	**N**	**O**	
_._	._..	__	_.	___	
P	**Q**	**R**	**S**	**T**	
.__.	__._	._.	...	_	
U	**V**	**W**	**X**	**Y**	**Z**
.._	..._	.__	_.._	_.__	__..

Results: ____

____

____

Conclusion: ____

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125

Morse Code

Topics: Electricity Coordination

Aim: To produce a simple Morse code sender and practice “SOS TITANIC”

Equipment

tapping key
Ticker Timer, or lamp
Power supply, 6V AC
connecting leads, 3

Procedure

Connect the tapping key and ticker timer in a series circuit with the power supply, 6V AC.
The Ticker timer will act as a buzzer
Use the tapping key and the code below to send the message.

A	B	C	D	E	
·–	–···	–·–·	–··	·	
F	G	H	I	J	
··–·	––·	····	··	·–––	
K	L	M	N	O	
–·–	·–··	––	–·	–––	
P	Q	R	S	T	
·––·	––·–	·–·	···	–	
U	V	W	X	Y	Z
··–	···–	·––	–··–	–·––	––··

Result:

Conclusion: The Morse code is in some ways similar to a bar code.

Risk Level: Low Hazard:

STUDENT:____________________

126

Nematodes

Aim: to observe nematodes in the local environment.

Equipment

nutrient agar 2%
microscope slides

Procedure

Place a drop of nutrient agar on a microscope slide and then press another slide on top. Allow to cool and set.
Place these slide pairs in various places such as as compost heaps, lawn, garden, bare earth, Lab Bench, for 24hrs.
Clean the slide faces and use a microscope on low power to look at the invertebrates within (nematodes).

Hint: If you intend to leave the slides for more than 24hrs a small amount of fungicide must be added to the agar.

Results: ____

____

____

Conclusion: ____

____

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126

Nematodes

Topics: Invertebrates Ecosystems

Aim: to observe nematodes in the local environment.

Equipment

nutrient agar 2%
microscope slides

Procedure

Place a drop of nutrient agar on a microscope slide and then press another slide on top. Allow to cool and set.
Place these slide pairs in various places such as as compost heaps, lawn, garden, bare earth, Lab Bench (control), for 24hrs.
Clean the slide faces and use a microscope on low power to look at the invertebrates within (nematodes).

Hint: If you intend to leave the slides for more than 24hrs a small amount of fungicide must be added to the agar.

Result: Nematodes were seen in almost all the slides provided they were sheltered from the sun.

Conclusion: Nematodes are a common invertebrate in the environment.

Risk Level: Low Hazard

STUDENT:____________________

127 Optical Illusions

Aim: To observe that sight has definite limitations and is a mental construct of images from the eyes.

Equipment

From the Library:
- Book of Escher Drawings
- Encyclopaedia with colour blindness plates.

Colour Blind Staff member
Retort stand

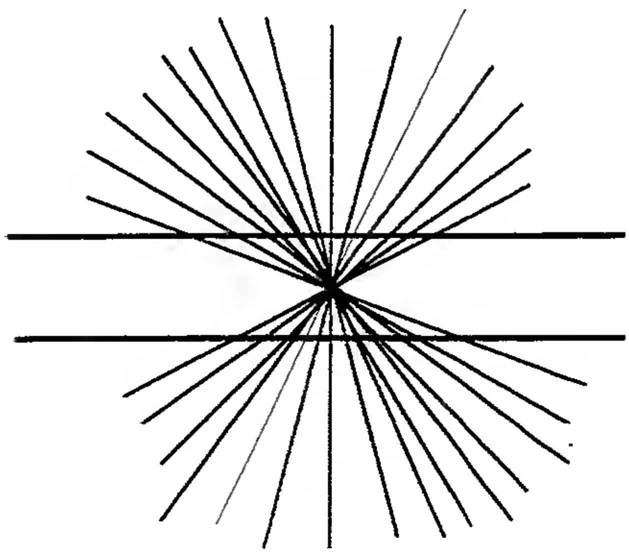
Procedure

1. Examine the colour blindness plates. How many students in your class are clour blind?____ How many are male?___

2. Roll a paper tube about 2cm diameter
Place the tube over the left eye then look at the left edge of the right hand with both eyes open. There should appear to be a hole in your hand.
3. Look at the diagrams below: the horozontal lines appear to be bowed. Use a ruler to check the lines.

4. Place a retort stand in front of a student. The student holds their right arm out from their side and attempts to swing it around to touch the stand rod with their index finger. Spin student and repeat the attempt with one eye closed.

6. Examine the Escher diagrams. Describe some of the illusions you find.



Results: ____

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Conclusion: ____

____

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127

Optical Illusions

Topics: Coordination Light

Aim: To observe that sight has definite limitations and is a mental construct of images from the eyes.

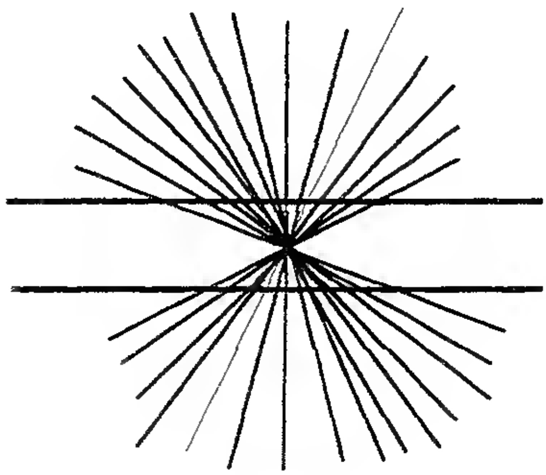
Equipment

From the Library:
- Book of Escher Drawings
- Encyclopaedia with colour blindness plates.

Colour Blind Staff member
Retort stand

Procedure

1. Have the students individually examine the colour blindness plates (nearly ten percent of males are Red/Green colour blind) Tests are rarely done anymore.
2. Have your colour blind staffer relate some amusing confusions they have experienced.
3. Have the students roll a paper tube about 2cm diameter Place the tube over the left eye then look at the left edge of the right hand with both eyes open. There should appear to be a hole in your hand.
4. Look at the diagrams below: the horozontal lines appear to be bowed. Use a ruler to check the lines.
5. Place a retort stand in front of a student. The student holds their right arm out from their side and attempts to swing it around to touch the stand rod with their index finger. Spin student and repeat the attempt with one eye closed6. Allow the students to examine the Escher diagrams



Result:

Conclusion: Images from the eyes are interpreted by the brain as part of the three dimensional world. Two dimensional images can often be confusing when interpreted this way. Artists use distortion in paintings to give the impression of depth and distance. True depth perception requires stereoscopic vision. Pilots must have both eyes and no colour blindness.

Risk Level: Low Hazard

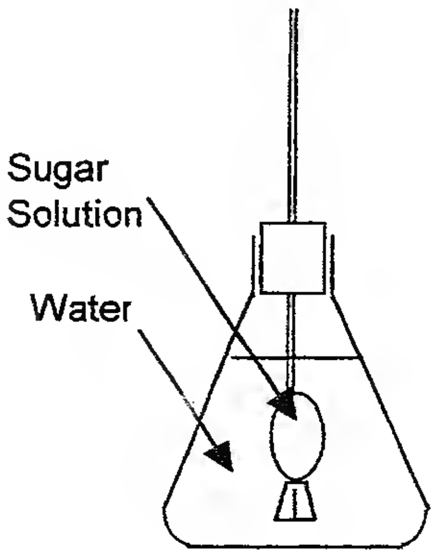
STUDENT:____________________

Osmosis

Aim: To demonstrate a means by which plants may draw water from the soil to their leaves.

Equipment
Dialysis tubing
Syringe
Glass tube through a stopper
Rubber Band
Wide mouthed flask
Glucose powder

Procedure
Add 10g of glucose to 50ml of water and dissolve with heating.
Soak 30cm of dialysis tubing for 20mins in water.
Tie a knot in one end of the tubing (do not stretch the long end).
Syringe glucose solution into the tube.
Insert the glass tubing into the dialysis tube and seal with the rubber band.
Lower the dialysis bag into a flask filled with water.



Results: ____

____

____

Conclusion: ____

____

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128

Osmosis

Topics: Plants

Aim: To demonstrate a means by which plants may draw water from the soil to their leaves.

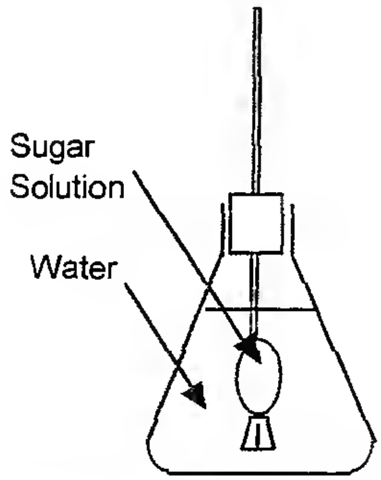
Equipment

Dialysis tubing
Syringe
Glass tube through a stopper
Rubber Band
Wide mouthed flask
Glucose powder

Procedure

Add 10g of glucose to 50ml of water and dissolve with heating.
Soak 30cm of dialysis tubing for 20mins in water.
Tie a knot in one end of the tubing (do not stretch the long end).
Syringe glucose solution into the tube.
Insert the glass tubing into the dialysis tube and seal with the rubber band.
Lower the dialysis bag into a flask filled with water.

A control would involve a duplicate however the dialysis bag would be filled only with water



Result: Water rises into the glass tubing and continues to rise at about 1cm per minute

Conclusion: Water flows across the dialysis membrane to dilute the glucose until there is an equal concentration on both sides of the membrane. Glucose molecules are too large to cross the membrane.

Risk Level: Low Hazard

STUDENT:________________

129

Osmosis 2

Aim: To determine the best mixture for keeping cut flowers.

Equipment

Flower cuttings, fresh
Gas Jars, 3
Sugar

Procedure

Add 200ml of water to each gas jar.
Add 1g of sugar to one jar and dissolve.
Add 50g of sugar to the second jar and stir.
Place a long cutting (with approximately equal leaf growth) into each jar.
Leave the jars in a sunny position, checking the cuttings and replacing the solutions each day

Results: ____________________

____

____

Conclusion: ____________________

____

____

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129

Osmosis 2

Topics: Plants

Aim: To determine the best mixture for keeping cut flowers.

Equipment

Flower cuttings, fresh
Gas Jars, 3
Sugar

Procedure

Add 200ml of water to each gas jar.
Add 1g of sugar to one jar and dissolve.
Add 50g of sugar to the second jar and stir.
Place a long cutting (with approximately equal leaf growth) into each jar.
Leave the jars in a sunny position, checking the cuttings and replacing the solutions each day

Result: The cutting in the strong sugar solution wilted first followed some days later by the cutting in plain water followed finally by the cutting in weak sugar solution.

Conclusion: While plants need sugar and minerals, an excess of either in the water creates an osmotic gradient too strong for the plant to draw water. A small amount of sugar will help the plant survive provided it does not encourage microbes in the water which attack the plant.

Risk Level: Low Hazard.

STUDENT:____________________

130 Oxidation & Reduction

Aim: To observe Metal/ Metal ion displacement reactions and so produce a limited activity series.

Equipment

Magnesium Nitrate, 1%
Lead Nitrate, 0.1M (3%)
Copper Nitrate, 0.1M (2%)
Zinc Nitrate , 0.1M (2%)
Copper Strips
Lead Shot
Zinc Metal
Magnesium Ribbon
test tubes, four
test tube rack
Steel wool

Procedure

Place a piece of zinc in each of four test tubes.
In tube 1 cover the metal with magnesium nitrate solution, tube 2, lead nitrate solution, tube 3, copper nitrate solution, tube 4, zinc nitrate solution.
Record any changes in the table below.
Empty the tubes into a beaker (not the sink) and rinse.
Repeat the experiment using lead shot.
Repeat the experiment using copper strips.
Repeat the experiment using magnesium ribbon (first clean the ribbon using steel wool).

Empty the waste beaker without pouring metals down the sink.
Rinse and return the metals to the teacher.

Metal	Magnesium Nitrate	Lead Nitrate	Copper Nitrate	Zinc Nitrate
Magnesium				
Lead				
Copper				
Zinc				

Results: ____

____

____

Conclusion: ____

____

____

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130

Oxidation & Reduction

Topics: Chemical Reactions Ions

Aim: To observe Metal/ Metal ion displacement reactions and so produce a limited activity series.

Equipment

Magnesium Nitrate, 1%
Lead Nitrate, 0.1M (3%)
Copper Nitrate, 0.1M (2%)
Zinc Nitrate , 0.1M (2%)
Copper Strips
Lead Shot
Zinc Metal
Magnesium Ribbon
test tubes, four
test tube rack
Steel wool

Procedure

Place a piece of zinc in each of four test tubes.
In tube 1 cover the metal with magnesium nitrate solution, tube 2, lead nitrate solution, tube 3, copper nitrate solution, tube 4, zinc nitrate solution.
Record any changes in the tubes.
Repeat the experiment using lead shot.
Repeat the experiment using copper strips.
Repeat the experiment using magnesium ribbon (first clean the ribbon using steel wool).

Tubes containing the same element as metal and as a salt anion are "Controls".

Result: Magnesium ribbon reacts with other metal salts. Zinc reacts with other metals except magnesium. Copper reacts only weakly with the lead nitrate. Lead cannot displace any of the other metals.

Conclusion: The order of activity from highest to lowest is magnesium, zinc, copper and finally lead. Being more reactive, magnesium will displace zinc , copper and lead ions from solution.

Risk Level: Moderate Hazard: All nitrates are to be considered oxidising agents and so isolated from other reactive chemicals. Lead nitrate is toxic if ingested, while the other metal nitrates are harmful if ingested. Skin contact is to be avoided and treated with vigorous washing.

STUDENT:____________________

131

Oxides & Acids

Aim: To determine the general reaction of metal oxides with acids.

Equipment

Test Tubes, four
Test Tube Rack
Sulfuric Acid, 1M, 5.5%
Hydrochloric Acid, 1M,10%
Copper Oxide
Zinc Oxide
Iron Oxide
Calcium Oxide

Procedure

Add a spatula of each oxide to separate test tubes.
Add 3cm of sulfuric acid to each tube.
Note any changes.
Clean the tubes and repeat the experiment with hydrochloric acid.

Oxide	Sulfuric	Hydrochloric
	Acid	Acid
Copper		
Zinc		
Iron		
Calcium		

Results: ____

____

____

Conclusion: ____

____

____

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131

Oxides & Acids

Topics: Acids and Bases

Aim: To determine the general reaction of metal oxides with acids.

Equipment

Test Tubes, four
Test Tube Rack
Sulfuric Acid, 1M, 5.5%
Hydrochloric Acid, 1M,10%
Copper Oxide
Zinc Oxide
Iron Oxide
Calcium Oxide

Procedure

Add a spatula of each oxide to separate test tubes.
Add 3cm of sulfuric acid to each tube.
Note any changes.
Clean the tubes and repeat the experiment with hydrochloric acid.

Result: Each of the oxides dissolved and some heat was produced. In the case of copper oxide, a blue solution formed with the sulfuric acid but a green solution formed with the hydrochloric acid.

Conclusion: ACID + METAL OXIDE > SALT + WATER The observation that copper oxide formed different coloured solutions with the different acids indicates that a different salt was formed in each case.

Risk Level: Mild Hazard: Calcium oxide is caustic to the skin and produces a lot of heat in its reaction with acids. Both acids are mildly corrosive in this concentration and any skin contact should be treated with vigorous washing. The soluble salts of zinc and copper are toxic if ingested.

STUDENT:____________________

132 Oxides/pH

Aim: To observe the reactions of metal and non-metal oxides with water.

Equipment

Test Tubes,large,four
stopper with delivery tube
Test Tube Rack
Universal Indicator,
(dropper bottle)
Calcium Oxide
Zinc Oxide
Ferrous Sulfate
Marble Chips
Hydrochloric Acid, 1M,10%
ferrous sulfate
Conical flask
Stopper with delivery pipe
test tube peg

Procedure

Add 5cm of water to both tubes.
Add 3 drops Universal indicator.
Add a small amount of calciuim oxide to one tube and zinc oxide to the other.
Warm both tubes in a Bunsen and record any changes.
Clean the tubes, replacing the water and indicator.
Place some marble chips in another test tube.
Add 10ml of acid and fit the stopper using the delivery tube to bubble the carbon dioxide gas into one test tube with water and universal indicator.

Record any change.
Place a small amount of ferrous sulfate in a dry tube.
Fit the stopper and delivery tube.
Heat this tube gently, bubbling any gas formed into a test tube with water and indicator.
Withdraw the delivery tube before removing the Bunsen.
Place the heated tube in the fume hood.
Record any changes in the water.

Oxide	Colour
Calcium	
Zinc	
Carbon	
Sulfur	

Results: ____

____

____

Conclusion: ____

____

____

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132

Oxides/pH

Topics: Salts Acids/Bases Chemical Reactions

Aim: To observe the reactions of metal and non-metal oxides with water.

Equipment

Test Tubes,large,four
stopper with delivery tube
Test Tube Rack
Universal Indicator,
(dropper bottle)
Calcium Oxide
Zinc Oxide
Ferrous Sulfate
Marble Chips
Hydrochloric Acid, 1M,10%
ferrous sulfate
Conical flask
Stopper with delivery pipe
test tube peg

Procedure

Add 5cm of water to both tubes.
Add 3 drops Universal indicator.
Add a small amount of calciuim oxide to one tube and zinc oxide to the other.
Warm both tubes in a Bunsen and record any changes.
Clean the tubes, replacing the water and indicator.
Place some marble chips in another test tube.
Add 10ml of acid and fit the stopper using the delivery tube to bubble the carbon dioxide gas into one test tube with water and universal indicator.

Record any change.
Place a small amount of ferrous sulfate in a dry tube.
Fit the stopper and delivery tube.
Heat this tube gently, bubbling any gas formed into a test tube with water and indicator.
Withdraw the delivery tube before removing the Bunsen.
Place the heated tube in the fume hood.
Record any changes in the water.

Result: The calcium oxide and zinc oxide turned the water basic while the gases produced an acidic reaction.

Conclusion: Metal oxides react with water to produce bases, while the non-metal oxides carbon dioxide and sulfur dioxide react with water to produce acids.

Risk Level: Moderate Hazard: Calcium oxide is caustic and attacks skin or moist membranes. Hydrochloric acid is corrosive and any contact on skin should be treated with washing. Heating of ferrous sulfate produces sulfur dioxide which in turn produces acids with any moisture. Any of the gas produced will dissolve in the water however if heating is stopped before the delivery tube is with drawn then water may be drawn up rapidly.

STUDENT:____________________

133

Oxygen

Aim: To produce oxygen gas and test some of its properties.

Equipment

Test tube, medium
Manganese Dioxide
Hydrogen Peroxide, 6%
Wooden splints
Bunsen Burner

Procedure

Add a spatula of manganese dioxide to the test tube.
Light the Bunsen.
Add 2 to 3cm of hydrogen peroxide to the test tube.
Seal the tube with a thumb.
Light the wooden splint in the Bunsen.
Blow out the flame.
While embers still glow plunge the splint into the test tube mouth.

Results: ____

____

____

Conclusion: ____

____

____

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133

Oxygen

Topics: Matter | Elements | The Atmosphere

Aim: To produce oxygen gas and test some of its properties.

Equipment
Test tube, medium
Manganese Dioxide
Hydrogen Peroxide, 6%
Wooden splints
Bunsen Burner

Procedure
Add a spatula of manganese dioxide to the test tube.
Light the Bunsen.
Add 2 to 3cm of hydrogen peroxide to the test tube.
Seal the tube with a thumb.
Light the wooden splint in the Bunsen.
Blow out the flame.
While embers still glow plunge the splint into the test tube mouth.

Result: Bubbles of gas were produced in the test tube which caused the glowing splint to burst into bright flames

Conclusion: Oxygen promotes burning and the "glowing splint test" confirmed that oxygen was produced in the reaction between manganese dioxide and hydrogen peroxide.

Risk Level: Moderate Hazard: Manganese Dioxide is of low toxicity . Hydrogen Peroxide is an oxidising agent to be poured only by the teacher (beware of eye splashes and over filling of test tubes). Students must not mix in any other reagents.

STUDENT:____________________

134

Oxygen in Air

Aim: To estimate the percentage of oxygen in air.

Equipment

Party Candle
30mm Cork
Hack saw Blade
Gas Jar
Pneumatic Trough or plastic tray
Porcelain bee hive or masses
Ruler

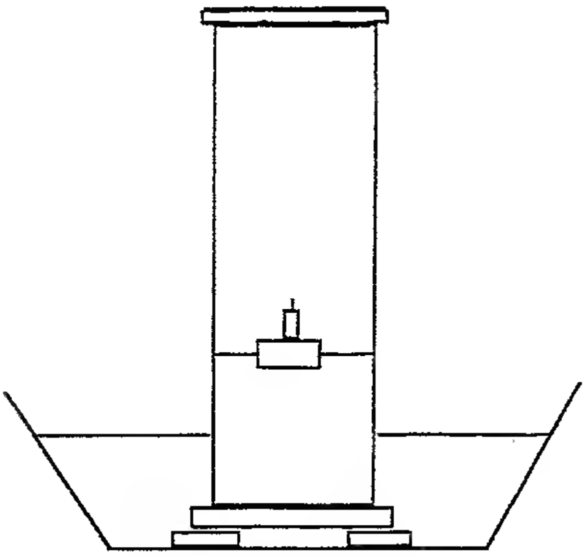
Procedure

Use the hack saw blade to cut the cork in half between its flat faces.
Cut the party candle to about 2cm length.
Use a pen to make a depression in the centre of the cork.
Fit the candle into the depression.
Fill the pneumatic trough or plastic tray with water.
Place the porcelain bee hive (or three masses) in the water.
Invert the gas jar and place it in the water resting on the bee hive (or the masses).

Measure the length of the air column in the gas jar (L1).____
Light the candle and float it on its cork base in the water.
Place the gas jar over the candle and rest it on the bee hive or mass supports.
Measure the air column when the candle burns out (L2).____

Percentage of oxygen in Air $= \frac{L1-L2}{L1} \times 100$

=



Results: ____

____

____

Conclusion: ____

____

____

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134

Oxygen in Air

Topics: Air Elements

Aim: To estimate the percentage of oxygen in air.

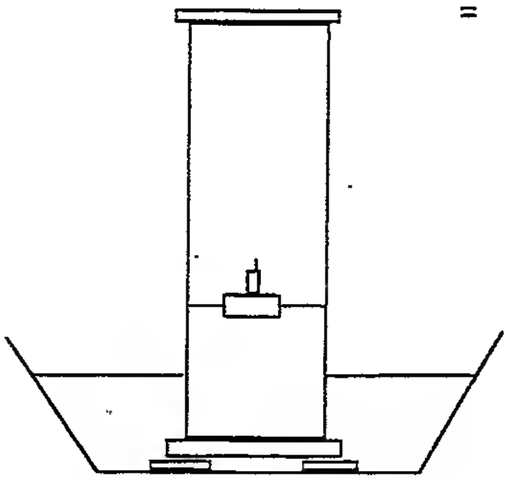
Equipment

Party Candle
30mm Cork
Hack saw Blade
Gas Jar
Pneumatic Trough or plastic tray
Porcelain bee hive or masses
Ruler

Procedure

Use the hack saw blade to cut the cork in half between its flat faces.
Cut the party candle to about 2cm length.
Use a pen to make a depression in the centre of the cork.
Fit the candle into the depression.
Fill the pneumatic trough or plastic tray with water.
Place the porcelain bee hive (or three masses) in the water.
Invert the gas jar and place it in the water resting on the bee hive (or the masses).

Measure the length of the air column in the gas jar (L1).___
Light the candle and float it on its cork base in the water.
Place the gas jar over the candle and rest it on the bee hive or mass supports.
Measure the air column when the candle burns out (L2).___
Percentage of oxygen in Air $= \frac{L1-L2}{L1} \times 100$
=



Result: The water level firstly falls and then begins to rise, continuing to rise after the candle has gone out.

Conclusion: The proportion of oxygen in air is about 20%. The water level firstly falls due to the heat expansion of air caused by the candle flame. The water level continues to rise after the candle goes out since the air is still cooling and contracting.

Risk Level: Low Hazard

STUDENT:__________________

135 Particle Refraction

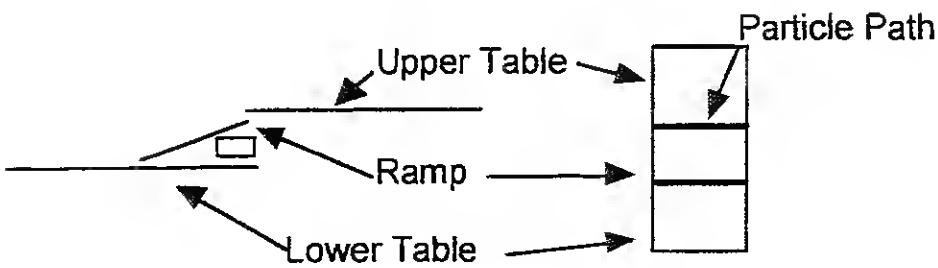
Aim: To demonstrate that particles as well as waves undergo refraction.

Equipment

Marbles
wooden ramp, 30 X 30 cm
six blocks or bricks

Procedure

Move two tables close together.
Support the legs of one table on blocks.
Connect the tables with ramp, supporting the ramp on blocks so its upper edge is just below the higher table.
Roll a marble on the higher table at an angle toward the ramp.
Draw the path the marble takes.



Results: ____

____

____

Conclusion: ____

____

____

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135

Particle Refraction

Topics: Waves Wave Prop. Light

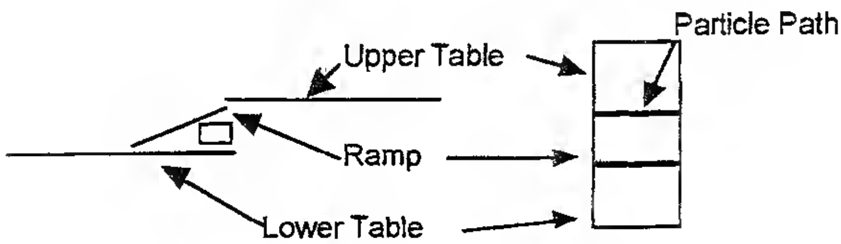
Aim: To demonstrate that particles as well as waves undergo refraction.

Equipment

Marbles
wooden ramp, 30 X 30 cm
six blocks or bricks

Procedure

Move two tables close together.
Support the legs of one table on blocks.
Connect the tables with ramp, supporting the ramp on blocks so its upper edge is just below the higher table.
Roll a marble on the higher table at an angle toward the ramp.
Draw the path the marble takes.



Result: The path of the marble straightens on the ramp then resumes its original course on the lower table.

Conclusion: Particles change direction as they change velocity just as waves do ie. acceleration alters the path toward the normal while deceleration produces the reverse.

Risk Level: Low Hazard

STUDENT:________________

136

Pendulum 1

Aim: To investigate the variables affecting the period of a pendulum.

Equipment

Mass Carrier
Masses, 3 X 50g
String, 1m
Retort stand and clamp
Stop watch.

Procedure

Set up the mass carrier as a pendulum swinging from the retort clamp.
Record the time to swing back and forth (the period).______
Vary the swing height and record the period.______
Add a mass to the carrier and record the new period.______
Add a second mass and record the period.______
Shorten the string length by one third and measure the period.______
Shorten the string length by the same amount again and measure the new period.______

Results: ____

____

____

Conclusion: ____

____

____

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136

Pendulum 1

Topics: Forces

Aim: To investigate the variables affecting the period of a pendulum.

Equipment

Mass Carrier
Masses, 3 X 50g
String, 1m
Retort stand and clamp
Stop watch.

Procedure

Set up the mass carrier as a pendulum swinging from the retort clamp.
Record the time to swing back and forth (the period)._____
Vary the swing height and record the period.______
Add a mass to the carrier and record the new period._____
Add a second mass and record the period.______
Shorten the string length by one third and measure the period.______
Shorten the string length by the same amount again and measure the new period.______

Result: The period of a pendulum is largely unaffected by the swing height or mass, only the string length has any affect.

Conclusion: the period of a pendulum is proportional to the square root of string length measured in metres (and inversely proportional to the square root of the acceleration due to gravity).

Risk Level: Low Hazard

STUDENT:__________________

137

Pendulum 2

Aim: To investigate the variables affecting the period of a pendulum.

Equipment

Mass Carrier
Masses, 3 X 50g
String, 1m
Retort stand and clamp
Stop watch.

Procedure

Set up the mass carrier as a pendulum swinging from the retort clamp.
Record the time to swing back and forth (the period).
Vary the swing height three times recording the period.
Add a mass to the carrier and record the new period.
Add a second mass and record the period.
Add a third mass and record the period
Shorten the string length by 20% and measure the period.
Shorten the string length by the same amount again and measure the new period

Shorten the string length once more by the same amount and record the new period.

Graph your results as Period versus mass and Log(Period) versus Log (L) where "L" is length
Infer a mathematical formula for the period of a pendulum from the graphs.

Mass	Length	Period	Log Length	Log Period

Results: ______________________________

____

____

Conclusion: ______________________________

____

____

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137

Pendulum 2

Topics: Forces

Aim: To investigate the variables affecting the period of a pendulum.

Equipment

Mass Carrier
Masses, 3 X 50g
String, 1m
Retort stand and clamp
Stop watch.

Procedure

Set up the mass carrier as a pendulum swinging from the retort clamp.
Record the time to swing back and forth (the period).
Vary the swing height three times recording the period.
Add a mass to the carrier and record the new period.
Add a second mass and record the period.
Add a third mass and record the period
Shorten the string length by 20% and measure the period.
Shorten the string length by the same amount again and measure the new period

Shorten the string length once more by the same amount and record the new period.

Graph your results as Period versus mass and Log(Period) versus Log (L) where "L" is length
Infer a mathematical formula for the period of a pendulum from the graphs.

Result: The period of a pendulum is largely unaffected by the swing height or mass, only the string length has any affect.

Conclusion: The graph of Period versus mass is flat with a gradient of zero. The graph of period versus Log L has a gradient of 0.5 and an intercept of -0.3 Log T = 0.5Log L - 0.3 , T = 2(square root L) , the factor 2 being twice Pi divided by the square root of acceleration due to gravity.

Risk Level: Low Hazard

STUDENT:____________________

138 pH Rainbows

Aim: To demonstrate the range of colours formed by Universal indicator

Equipment	**Procedure**
Calcium Hydroxide	Place a spatula of calcium hydroxide into a test tube.
Universal Indicator	Add four drops of Universal indicator.
Hydrochloric Acid,1M, 10%	Half fill the test tube with the acid.
Test tube	Hold the top of the test tube firmly between finger and thumb.
	Flick the base of the test tube to produce a swirling inside.
	Allow the colour layers to develop.

Results: ____

____

____

Conclusion: ____

____

____

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138

pH Rainbows

Topics: Acids/Bases

Aim: To demonstrate the range of colours formed by Universal indicator

Equipment

Calcium Hydroxide
Universal Indicator
Hydrochloric Acid, 1M, 10%
Test tube.

Procedure

Place a spatula of calcium hydroxide into a test tube.
Add four drops of Universal indicator.
Half fill the test tube with the acid.
Hold the top of the test tube firmly between finger and thumb.
Flick the base of the test tube to produce a swirling inside.
Allow the colour layers to develop.

Result: The tube becomes banded with colours, red at the top, orange then yellow, green, blue and violet at the bottom.

Conclusion: A range of pH exists in the tube due to incomplete reaction of the acid and the base. Acid persists at the top and alkaline conditions persist around the remaining hydroxide in the base.

Risk Level: Moderate Hazard: Hydrochloric acid , 1M, is mildly corrosive and skin contact should be treated by vigorous washing. Calcium hydroxide is mildly caustic and should be kept away from eyes.

STUDENT:________________

139 Photochemical Reaction

Aim: To demonstrate that making photographic images is a light activated chemical reaction.

Equipment

Black and White Film
Camera
Access to a dark room Each student takes a photograph.

Procedure

Explain the chemical steps below;

Exposing the negative:________________

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Developing the negative:________________

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Fixing the Negative:________________

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Exposing the Print (positive):________________

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Developing the Print: ________________

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Fixing the Print:________________

Additional Steps:________________

Results: ________________

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Conclusion: ________________

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139

Photochemical Reaction

Topics: Light Chemical Energy

Aim: To demonstrate that making photographic images is a light activated chemical reaction.

Equipment

Black and White Film
Camera
Access to a dark room
Each student takes a photograph.

Procedure

Explain the chemical steps below;
Exposing the negative: The camera shutter briefly exposes the film to light which lowers the activation energy of silver ions in the cellulose strip.
Developing the negative: A weak reducing agent reduces the activated ionic silver to black silver atoms.

Fixing the Negative: Sodium Thiosulfate stabilises the black silver and dissolves out the remaining ionic silver.

Exposing the Print (positive): A strong light shone through the negative produces a positive image on paper containing ionic silver.

Developing the Print: A weak reducing agent again converts the activated silver ions into black silver atoms.

Fixing the Print: Sodium Thiosulfate stabilises the image.

Additional Steps: Gloss is used for shiny prints.

Result:

Conclusion: Silver chloride embedded in methyl cellulose is exposed to light, lowering the activation energy. Adding a weak reducing agent causes formation of black particles of Silver. Sodium Thiosulfate (Fixer) stabilises the silver grains and dissolves the unexposed silver chloride. The negative (or print) can now be viewed in full light without further darkening.

Risk Level: Mild Hazard: Every student should see the magic of a print developing before their eyes, however in a dark room someone always wants to be a clown and so small groups are essential.

STUDENT:____________________

140 Photosynthesis 1

Aim: To demonstrate that photosynthesis produces carbohydrate.

Equipment	**Procedure**
Potted Plant : Large soft leafs eg coleus	Cover part of a leaf on both sides with aluminium foil held in place with paper clips.
Aluminium Foil	Place the plant in a sunny position.
Paper clips, 4	Next day, remove the leaf, remove the foil and then boil the leaf for five minutes in a beaker of water.
Iodine Soln (See Food tests)	Discard the water and cover the leaf in methylated spirits.
Methylated Spirits	Leave overnight for the pigments to leach out.
Beaker,200ml	Pour off the alcohol.
Filter Paper	Soak the leaf for 5 minutes in Iodine solution.
Forceps	Spread the leaf on a filter paper.

Results: ____

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Conclusion: ____

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140

Photosynthesis 1

Topics: Energy in Life Biological Chem Plants

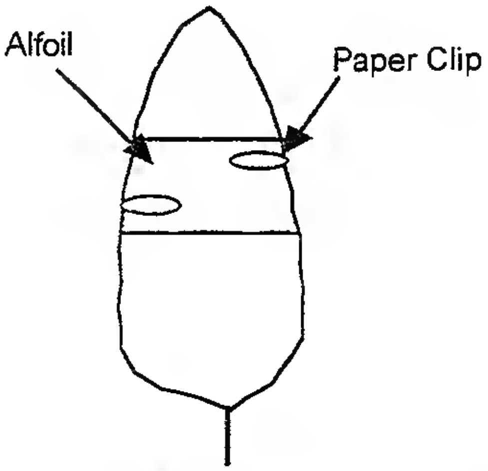
Aim: To demonstrate that photosynthesis produces carbohydrate.

Equipment

Potted Plant : Large soft leafs eg coleus
Aluminium Foil
Paper clips, 4
Iodine Soln (See Food tests)
Methylated Spirits
Beaker,200ml
Filter Paper
Forceps

Procedure

Cover part of a leaf on both sides with aluminium foil held in place with paper clips.
Place the plant in a sunny position.
Next day, remove the leaf, remove the foil and then boil the leaf for five minutes in a beaker of water.
Discard the water and cover the leaf in methylated spirits.
Leave overnight for the pigments to leach out.
Pour off the alcohol.
Soak the leaf for 5 minutes in Iodine solution.
Spread the leaf on a filter paper.



Result: The leaf portion not covered with aluminium foil stained blue/black .

Conclusion: Iodine solution stains starch blue/black. The experiment indicates that exposure to light allows the formation of starch. The portion covered with alfoil used its starch reserves during the night and was not able to regenerate starch without sunlight, hence Photosynthesis produces starch carbohydrate.
note: the uncovered leaf portions act as a control.

Risk Level: Low Hazard: Iodine Solution is harmful if ingested and stains the skin. Some individuals can be hypersensitive to molecular Iodine. Methylated Spirits is a flammable liquid which must be isolated from flames or oxidising agents.

STUDENT:____________________

141

Photosynthesis 2

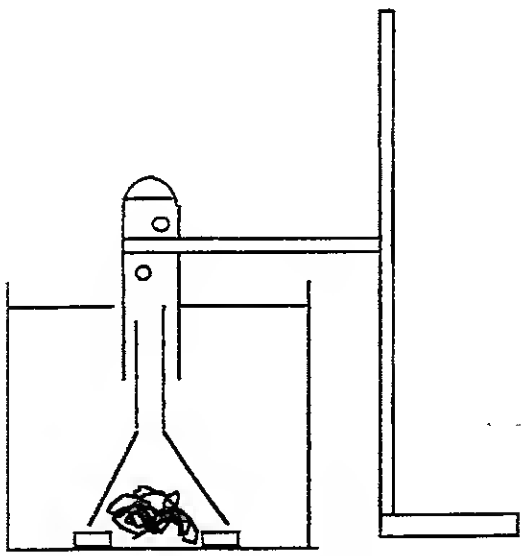
Aim: To demonstrate that photosynthesis produces oxygen.

Equipment

beaker, 1litre
Sodium Bicarbonate
Algae, eg Elodea
Filter funnel
Test tube
Retort stand and clamp

Procedure

Add 0.2g sodium hydrogen carbonate to the beaker.
Fill the beaker with water and stir.
Place a large clump of algae in the water.
Place an inverted funnel over the algae (the spout should be below the water surface).
Fill a test tube with water and invert it over the funnel spout avoiding any air bubbles.
Raise the test tube and support it with a retort and clamp.
Leave the apparatus in a sunny position for several days.



Results: ____

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Conclusion: ____

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141

Photosynthesis 2

Topics: Plants Energy in Life Biological Chem

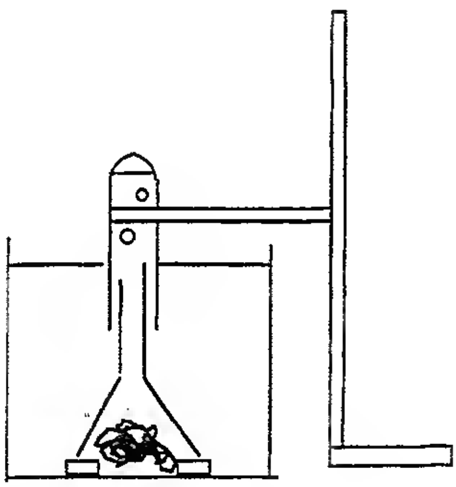
Aim: To demonstrate that photosynthesis produces oxygen.

Equipment

beaker, 1litre
Sodium Bicarbonate
Algae, eg Elodea
Filter funnel
Test tube
Retort stand and clamp

Procedure

Add 0.2g sodium hydrogen carbonate to the beaker.
Fill the beaker with water and stir.
Place a large clump of algae in the water.
Place an inverted funnel over the algae (the spout should be below the water surface).
Fill a test tube with water and invert it over the funnel spout avoiding any air bubbles.
Raise the test tube and support it with a retort and clamp.
Leave the apparatus in a sunny position for several days.



Result: Gas accumulates in the test tube.

Conclusion: The algae is able to use carbon dioxide dissolved in the water to produce oxygen gas via photosynthesis.

Risk Level: Low Hazard

STUDENT:______________________

142

Plant Tropisms

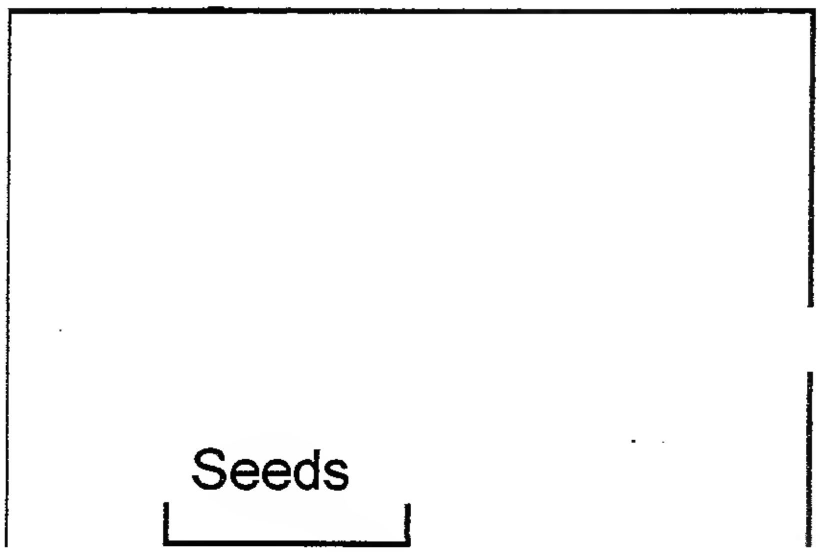
Aim: To demonstrate the Phototropic response of plants.

Equipment

Seeds (Radish)
Petri Dishes
cotton wool
cardboard box

Procedure

Germinate the seeds in wet cotton wool.
Make a single hole (3cm) in the side of the box .
Cover the seeds with the box and rotate daily.



Results: ____

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Conclusion: ____

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142

Plant Tropisms

Topics: Plants Coordination

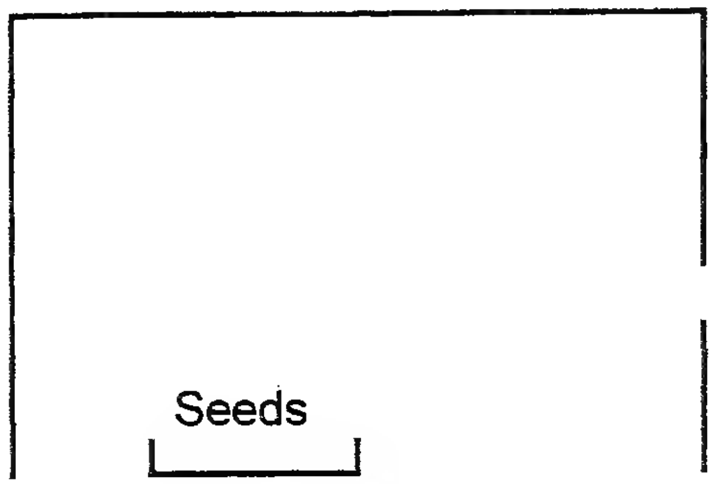
Aim: To demonstrate the Phototropic response of plants.

Equipment

Seeds (Radish)
Petri Dishes
cotton wool
cardboard box

Procedure

Germinate the seeds in wet cotton wool.
Make a single hole (3cm) in the side of the box .
Cover the seeds with the box and rotate daily.



Result: The seedlings grew in a cork screw pattern.

Conclusion: Seedlings will grow toward the sunlight.

Risk Level: Low Hazard

STUDENT:____________________

143

Polar Liquids

Aim: To perform a simple test for polar liquids.

Equipment	**Procedure**
Burette	Fill the burette with water.
Retort stand, clamp	Support the Burette on the retort stand so there is 10cm between the stop cock and collecting beaker.
Methanol	Adjust the flow so a thin continuous stream is falling.
Propanol	Charge the rod by rubbing with the cloth.
Olive Oil	Hold the rod close to the stream of falling liquid.
Acetone	Record whether or not the stream is deflected.
Perpex Rod	Rinse the burette with methanol.
Woollen cloth	Repeat the test for the other liquids.
Beaker 400ml	

Results: ____

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Conclusion: ____

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143

Polar Liquids

Topics: Ions Solubility

Aim: To perform a simple test for polar liquids.

Equipment	**Procedure**
Burette	Fill the burette with water.
Retort stand, clamp	Support the Burette on the retort stand so there is 10cm between the stop cock and collecting beaker.
Methanol	Adjust the flow so a thin continuous stream is falling.
Propanol	Charge the rod by rubbing with the cloth.
Olive Oil	Hold the rod close to the stream of falling liquid.
Acetone	Record whether or not the stream is deflected.
Perpex Rod	Rinse the burette with methanol.
Woollen cloth	Repeat the test for the other liquids.
Beaker 400ml	

Result: The falling liquid stream deflected strongly for water, weakly for methanol and propanol, but not at all for olive oil and ethyl acetate.

Conclusion: Water, Methanol and Ethanol have polar molecules and so can experience an electrostatic attraction by induction. Olive Oil and Ethyl Acetate are non-polar and so experience no attraction to the charged rod.

Risk Level: Mild Hazard: Methanol, Propanol and Acetone are all volatile, inflamable liquids and must be isolated from flames. Being volatile these liquids will produce copious fumes under these conditions. The room must be well ventillated and Asthmatics may be excused unless the experiment is performed as a demonstration in a fume hood. Acetone wastes should be collected in a waste bottle in the fume hood.

STUDENT:____________________

144

Polarisation

Aim: To demonstrate some examples of natural polarisation

Equipment

Polaroid Sheets,2
Pond or Sheet of glass

Note: See Sunset Experiment

Procedure

Hold a Polaroid sheet up to a fluorescent light.
Rotate the sheet and observe any change.
Place a second sheet in front of the other. Rotate the second sheet relative to the first and observe any change.
Go outside and observe the sky close to the sun through a polarised sheet. Rotate the sheet.
Turn toward the sky 90 degrees from the sun. Rotate the sheet again.
Position yourself to observe the reflective glare from a pond or glass sheet.

Observe the glare through the Polarised sheet. Rotate the sheet.

Results: ____

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Conclusion: ____

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144

Polarisation

Topics: Light | Waves | Wave Prop Light

Aim: To demonstrate some examples of natural polarisation

Equipment

Polaroid Sheets,2

Pond or Sheet of glass

Note: See Sunset Experiment

Procedure

Hold a Polaroid sheet up to a fluorescent light.
Rotate the sheet and observe any change.
Place a second sheet in front of the other. Rotate the second sheet relative to the first and observe any change.
Go outside and observe the sky close to the sun through a polarised sheet. Rotate the sheet.
Turn toward the sky 90 degrees from the sun. Rotate the sheet again.
Position yourself to observe the reflective glare from a pond or glass sheet.

Observe the glare through the Polarised sheet. Rotate the sheet.

Result: When the polarised sheet were oriented at 90 degrees to each other, no light came through. Rotating a Polaroid sheet pointed at the sun made no difference but reflected glare and blue sky , were both dimmed.

Conclusion: Light from the Sun and Fluorescent Tubes is not polarised. Light reflected from surfaces, or scattered in in the sky, is polarised.

Risk Level: Low Hazard

STUDENT:____________________

145

Pollen Tubes

Aim: To observe pollen tubes from various plants

Equipment

Agar Agar
Sucrose
Petri Dishes
Fresh Flowers

Procedure

Prepare 100ml of 2% Agar and heat until it dissolves.
Add sugar to 2% and pour half of the mixture into petri dishes.
Add sugar to 10% in the remaining mixture and then pour into petri dishes.
Allow to cool then sprinkle with fresh pollen from several flower species.
Observe after a few minutes under a dissecting microscope.

Results: ____

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Conclusion: ____

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145

Pollen Tubes

Topics: Plants Reproduction

Aim: To observe pollen tubes from various plants

Equipment

Agar Agar
Sucrose
Petri Dishes
Fresh Flowers

Procedure

Prepare 100ml of 2% Agar and heat until it dissolves.
Add sugar to 2% and pour half of the mixture into petri dishes.
Add sugar to 10% in the remaining mixture and then pour into petri dishes.
Allow to cool then sprinkle with fresh pollen from several flower species.
Observe after a few minutes under a dissecting microscope.

Result: Some species of pollen grow rapidly on 2% sugar agar while others grow on 10% sugar agar.

Conclusion: Sucrose concentration is an important trigger for pollen tube formation.

Risk Level: Low Hazard

STUDENT:____________________

146

Pond Ecosystem

Aim: To determine the health of a fresh water ecosystem by simple examination of its diversity.

Equipment

Dip Net
Sample jars

Optional : Streamwatch Kit - Turbidometer, pH meter, Thermometer, Nitrate Test Kit, Phosphate Test Kit, Dissolved Oxygen Test Kit.

Procedure

Examine the diversity of life in the pond, particularly larval insect forms.
Make notes on the presence of fish, frogs and other vertebrates.
Note the variety of plant life and the amount of clear surface.
This constitutes the Biotic Environment.
Measurements with a Streamwatch kit will define the Physical Environment.

Life forms	Physical Measurements

Results: ____

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Conclusion: ____

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146

Pond Ecosystem

Topics: Communities Ecosystems

Aim: To determine the health of a fresh water ecosystem by simple examination of its diversity.

Equipment

Dip Net
Sample jars

Optional : Streamwatch Kit - Turbidometer, pH meter, Thermometer, Nitrate Test Kit, Phosphate Test Kit, Dissolved Oxygen Test Kit.

Procedure

Examine the diversity of life in the pond, particularly larval insect forms.
Make notes on the presence of fish, frogs and other vertebrates.
Note the variety of plant life and the amount of clear surface.
This constitutes the Biotic Environment.
Measurements with a Streamwatch kit will define the Physical Environment.

Result: Diversity will be poor in badly polluted ponds with plant growth either dominant due to nutrients or completely absent due to toxins.

Conclusion: The Physical and Biotic Environment are linked in that an unhealthy physical environment will reduce the diversity in the biotic environment. Knowing which species are most sensitive to pollution or changes means that the physical health of an ecosystem can be estimated by the absence of the sensitive species such as Stonefly and Mayfly nymphs

Risk Level: Low Hazard : Provided you choose a cool day when students are not tempted to "fall" in.

STUDENT:____________________

147 **Precipitation Rns**

Aim: To determine which combinations of various chemicals will produce precipitates.

Equipment

Potassium Carbonate,2%
Sodium Hydroxide, 2%
Zinc Chloride, 2%
Copper Sulfate, 2%
Lead Nitrate, 2%
Sodium Nitrate, 2%
test tubes, six

Procedure

Add 2 cm of the of the carbonate solution to each test tube.
Add a 2cm sample of the remaining salt solutions to the test tubes.
Record the results in a table.
Empty and rinse the tubes.

Repeat for the hydroxide solution.
Repeat for the chloride solution.
Repeat for the sulfate solution.
Repeat for the Lead nitrate solution.

Salt Cation	Carbonate	Hydroxide	Chloride	Sulfate	Lead Nitrate
Potassium					
Sodium					
Zinc					
Copper					
Lead					
Sodium					

Results: ____

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Conclusion: ____

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147

Precipitation Rns

Topics: Chem Reactions Solubility

Aim: To determine which combinations of various chemicals will produce precipitates.

Equipment

Potassium Carbonate,2%
Sodium Hydroxide, 2%
Zinc Chloride, 2%
Copper Sulfate, 2%
Lead Nitrate, 2%
Sodium Nitrate, 2% (control)
test tubes, six

Procedure

Add 2 cm of the of the carbonate solution to each test tube.
Add a 2cm sample of the remaining salt solutions to the test tubes.
Record the results in a table.
Empty and rinse the tubes.

Repeat for the hydroxide solution.
Repeat for the chloride solution.
Repeat for the sulfate solution.
Repeat for the Lead nitrate solution.

Result: The carbonate formed a precipitate in three cases and so did the hydroxide. The sulfate formed only one precipitate and so did the chloride. The lead nitrate formed four precipitates while the sodium nitrate formed none.

Conclusion: Carbonates and hydroxides are mostly insoluble. sulfates and chlorides are often insoluble. Nitrates are are always soluble. Heavy metals such as lead are usually insoluble salts.

Risk Level: Moderate Hazard: Sodium hydroxide is caustic and any skin contact should be treated with vigorous washing. Copper sulfate and zinc chloride are harmful if ingested and may irritate the skin. Lead nitrate is toxic and skin contact must be avoided.

STUDENT:____________________

148

Projectiles 1

Aim: To calculate the height and velocity of a ball thrown in the air from its time of flight.

Equipment

Tennis ball
Stop watch

Procedure

Throw the ball straight up using the stop watch to record its time of flight.

Since the time to ascend is equal to the time of decent then half the time of flight is equal to 't' the time required to fall from maximum height.

$s = ut + 1/2at^2$, where $u = 0$ and $a = 9.8$

The initial velocity of the ball is found from

$v = u + at$, where $a = -9.8$, $v = 0$

Results: ____

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Conclusion: ____

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148

Projectiles 1

Topics: Linear Motion Gravity

Aim: To calculate the height and velocity of a ball thrown in the air from its time of flight.

Equipment

Tennis ball

Stop watch

Procedure

Take students outside and ask them to throw the ball straight up using the stop watch to record its time of flight.

Since the time to ascend is equal to the time of decent then half the time of flight is equal to 't' the time required to fall from maximum height.

$s = ut + 1/2at^2$, where $u = 0$ and $a = 9.8$

The initial velocity of the ball is found from

$v = u + at$, where $a = -9.8$, $v = 0$

Result: Times of flight may reach 5 seconds.

Conclusion: Velocities of 80km/hr are achievable reaching heights of 25 metres.

Risk Level: Low Hazard

STUDENT:________________

Quantum Leaps

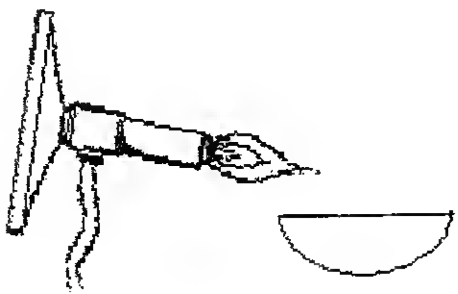
Aim: To observe that when heated, different elements will produce different colours in a flame.

Equipment

Evaporating Basin
Hydrochloric Acid 1M, 10%
Sodium Carbonate
Strontium Carbonate
Copper Carbonate
Bunsen

Procedure

Add 20ml of acid to the evaporating basin.
Add a spatula of sodium carbonate to the acid.
Direct a Bunsen flame over the liquid surface as the bubbles burst.
Clean the basin.
Repeat for strontium carbonate.
Repeat for copper carbonate.



Salt	Colour

Results: ____

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Conclusion: ____

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Quantum Leaps

Topics: Atoms & Molecules   Elements   Nuclear Physics

Aim: To observe that when heated, different elements will produce different colours in a flame.

Equipment

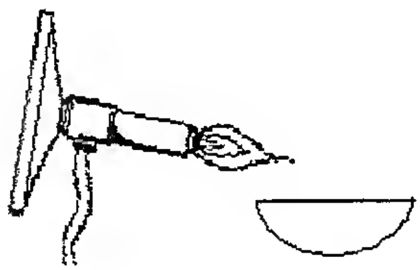
Evaporating Basin
Hydrochloric Acid 1M, 10%
Sodium Carbonate
Strontium Carbonate
Copper Carbonate
Bunsen

Procedure

Add 20ml of acid to the evaporating basin.
Add a spatula of sodium carbonate to the acid.
Direct a Bunsen flame over the liquid surface as the bubbles burst.
Clean the basin.
Repeat for strontium carbonate.
Repeat for copper carbonate.

Hint: If Strontium carbonate is unavailable use Strontium chloride with potassium carbonate. Lithium carbonate

also produces deep red flames and is an acceptable substitute.



Salt	Colour

Result: The flame became green when copper carbonate was reacting, red when strontium carbonate was reacting and yellow when sodium carbonate was reacting.

Conclusion: As the carbonate reacts with the acid, bubbles of carbon carbon dioxide are produced. As the bubbles of burst, tiny droplets of the solution are thrown up into the Bunsen flame. The droplets contain the dissolved metal ions which when heated, produce an individual emission spectrum of colour.

Risk Level: Low Hazard:

STUDENT:________________

150

Radio Waves

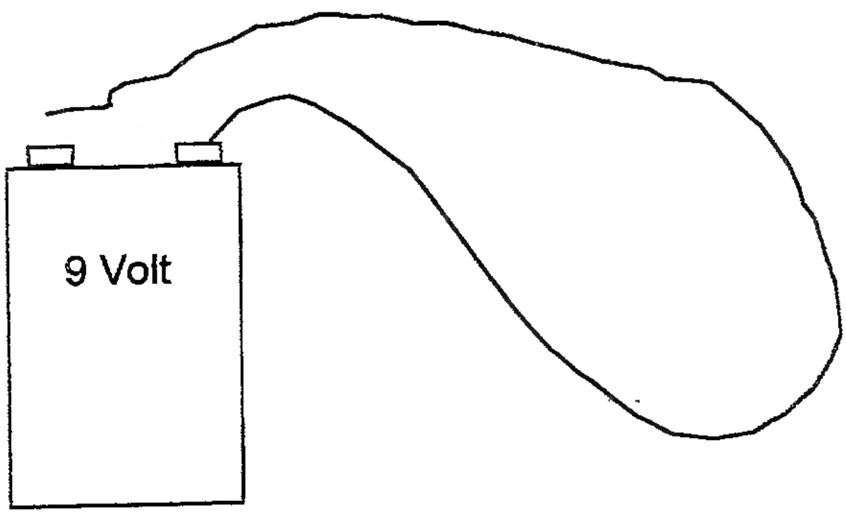
Aim: To demonstrate how simply radio waves may be produced.

Equipment

9 volt battery
Insulated wire, 0.25m
Insulated wire, 2.5m
Radio

Procedure

Turn on the radio and tune it to a quiet section of the AM dial.
Using the short wire, hold one end of the wire on one battery terminal while tapping the other end of the wire on the other terminal.
Gradually move the battery/wire transmitter away from the radio until the signal can no longer be heard.
Repeat the experiment with the long wire.



Results: ____

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Conclusion: ____

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150

Radio Waves

Topics: Waves Electricity

Aim: To demonstrate how simply radio waves may be produced.

Equipment

9 volt battery
Insulated wire, 0.25m
Insulated wire, 2.5m
Radio

Procedure

Turn on the radio and tune it to a quiet section of the AM dial.
Using the short wire, hold one end of the wire on one battery terminal while tapping the other end of the wire on the other terminal.
Gradually move the battery/wire transmitter away from the radio until the signal can no longer be heard.
Repeat the experiment with the long wire.

Result: Bursts of static are heard on the radio corresponding with the tapping on the battery/wire transmitter. The longer wire produced a signal which could be detected much further away.

Conclusion: Radio waves are produced by a flow of electrons in a wire. The strength of the signal is determined by the size of the current and the conductor (transmitter).

Risk Level: Low.

STUDENT:__________________

151

Rayon

Aim: To make Rayon polymer fibre from raw materials.

Equipment

Syringe, 20cc
Filter Paper
Hydrochloric Acid 0.2M,2%
beakers, 250ml, 2
Schweitzers Reagent :
Dissolve 10g copper Sulfate in 100ml water.Add 25ml of 10% sodium hydroxide. Mix then allow to stand.Decant the liquid.
Add 200ml water, stand and decant. Repeat three times. Filter and wash.
Dissolve in a minimum volume of 27% Ammonia.

Procedure

Tear up three pieces of 10cm filter paper into small pieces
In a Fume Hood:
Dissolve the paper in 100mls of Schweitzers reagent in a beaker.
Place 200mls of the hydrochloric acid in a second beaker.
Use the syringe to draw up the dissolved paper
Slowly inject the paper solution just below the surface of the acid.
A whitish fibre strand forms in the acid.
Wash the strand several times in water.

Results: ____

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Conclusion: ______________________________________

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151

Rayon

Topics: Organic Chemistry

Aim: To make Rayon polymer fibre from raw materials.

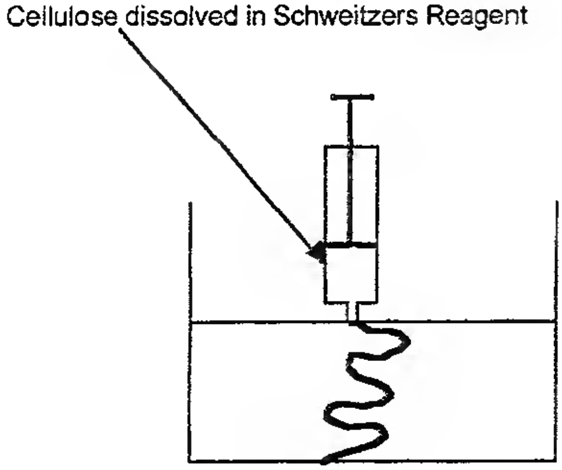
Equipment

Syringe, 20cc
Filter Paper
Hydrochloric Acid 0.2M,2%
beakers, 250ml, 2
Schweitzers Reagent :
Dissolve 10g copper Sulfate in 100ml water.Add 25ml of 10% sodium hydroxide. Mix then allow to stand.Decant the liquid. Add 200ml water, stand and decant. Repeat three times. Filter and wash. Dissolve in a minimum volume of 27% Ammonia.

Procedure

Tear up three pieces of 10cm filter paper into small pieces
In a Fume Hood:
Dissolve the paper in 100mls of Schweitzers reagent in a beaker.
Place 200mls of the hydrochloric acid in a second beaker.
Use the syringe to draw up the dissolved paper
Slowly inject the paper solution just below the surface of the acid.
A whitish fibre strand forms in the acid.
Wash the strand several times in water.

Hint: The ammonia concentration must be at least 15M.



Result: A soft whitish strand of Rayon is formed.

Conclusion: Schweitzers reagent consists of Cuprammonium solution $Cu(NH_3)_4(OH)_2$ which is capable of dissolving cellulose fibres into molecules. The dilute hydrochloric acid causes polymerisation of the cellulose into the plastic called Rayon.

Risk Level: HAZARDOUS: Senior students only. Ammonia 27% is strongly caustic and releases pungent, caustic fumes. This experiment should be carried only in a fume hood. The Schweitzer reagent should be prepared by the teacher or laboratory assistant and should remain in the fume hood throughout the practical class.

STUDENT:________________

152 Reaction Rate vs. Conc.

Aim: To measure the effect of reactant concentration on reaction rate.

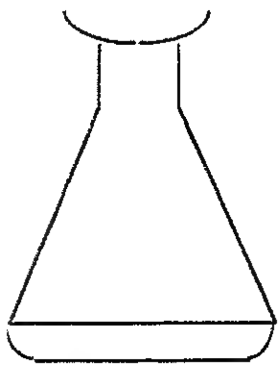
Equipment

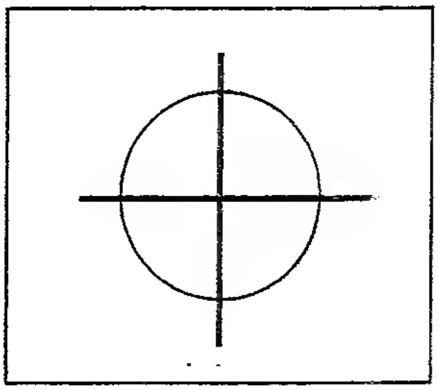
Sodium Thiosulfate, 0.25 M (6%)
Hydrochloric acid, 2M,20%
Distilled water,
Measuring Cylinders, 10ml, 25ml and 100ml
Conical Flasks,100ml, two
Stop watch
watch glass

Procedure

Mark a black cross on a piece of paper.
Add 45ml of the thiosulfate solution to the conical flask.
Place the flask over the cross marked on the paper.
Measure 5mls of the acid.
Start the stop watch as the acid is added to the flask,swirl the flask to mix and place the watch glass over the flask mouth.
Record the time at which the black cross can no longer be seen through the solution.
Empty the solution into a waste flask in a fume hood.

Rinse the the flask thoroughly.
Repeat the above steps four times, each time reducing the thiosulfate added by 10mls , replacing the reduced volume with distilled water.
Calculate the initial molar concentration of Thiosulfate in each case.
Plot the results on a graph of Thiosulfate Concentration versus the reciprocal of reaction time.





Results: ____

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Conclusion: ____

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152

Reaction Rate vs. Conc.

Topics: Equilibrium Chemical reactions

Aim: To measure the effect of reactant concentration on reaction rate.

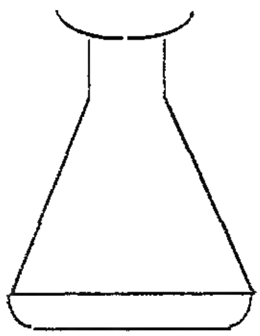
Equipment

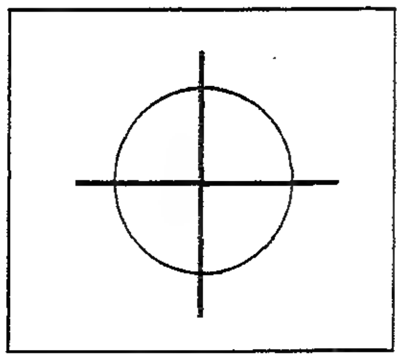
Sodium Thiosulfate, 0.25 M (6%)
Hydrochloric acid, 2M,20%
Distilled water,
Measuring Cylinders, 10ml, 25ml and 100ml
Conical Flasks,100ml, two
Stop watch
watch glass

Procedure

Mark a black cross on a piece of paper.
Add 45ml of the thiosulfate solution to the conical flask.
Place the flask over the cross marked on the paper.
Measure 5mls of the acid.
Start the stop watch as the acid is added to the flask, swirl the flask to mix and place the watch glass over the flask mouth.
Record the time at which the black cross can no longer be seen through the solution.
Empty the solution into a waste flask in a fume hood.

Rinse the the flask thoroughly.
Repeat the above steps four times, each time reducing the thiosulfate added by 10mls , replacing the reduced volume with distilled water.
Calculate the initial molar concentration of Thiosulfate in each case.
Plot the results on a graph of Thiosulfate Concentration versus the reciprocal of reaction time.





Result: Increasing the concentration of thiosulfate increased the rate of reaction

Conclusion: The rate of a reaction is proportional to the concentration of reactants.

Risk Level: Mild Hazard: The reaction of sodium thiosulfate and hydrochloric acid produces colloidal sulfur (see Sunset reaction) and sulfur dioxide. While predominately the sulfur dioxide dissolves in the solution, care should be taken in disposing of the mixture as the fumes are harmful if inhaled. Hydrochloric acid is corrosive and any contact with skin should be treated with vigorous washing.

STUDENT:________________

153 Reaction Rate vs. Temp

Aim: To measure the effect of temperature on a reaction.

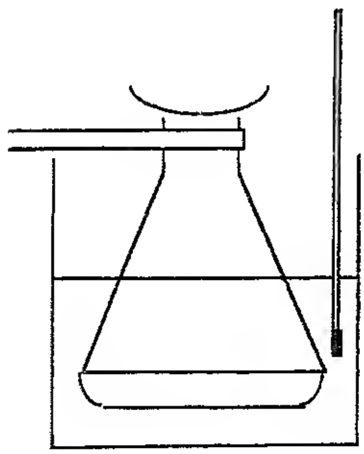
Equipment

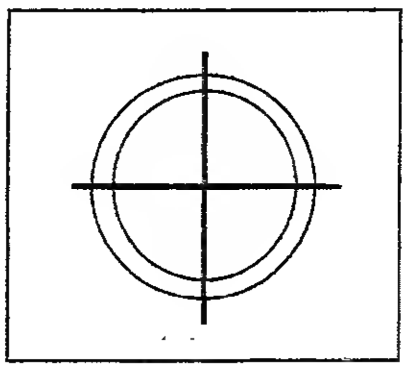
Sodium Thiosulfate, 0.08 M (2%)
Hydrochloric acid, 2M,20%
Distilled water,
Measuring Cylinders, 10ml, 25ml and 100ml
Conical Flask, 150ml
Stop watch
watch glass
Beaker, 400ml

Procedure

Mark a black cross on a piece of paper.
Place the beaker over the paper.
Add 100mls of ice water to the beaker.
Add 45ml of the thiosulfate solution to the conical flask.
After 5 minutes measure and record the temperature.
Measure 5mls of the acid.
Start the stop watch as the acid is added to the flask.
Swirl the flask and place the watch glass over the flask mouth.

Record the time at which the black cross can no longer be seen through the solution.
Empty the solution into a waste flask in a fume hood.
Rinse the the flask thoroughly.
Repeat the above steps four times, each time increasing the temperature of the beaker water by 15 degrees.
Plot the results on a graph of Temperature (degrees Kelvin) versus the reciprocal of reaction time.





Results: ____

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Conclusion: ____

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153
Reaction Rate vs. Temp

Topics: Equilibrium Chemical reactions

Aim: To measure the effect of temperature on a reaction.

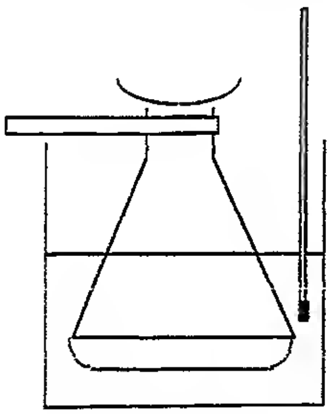
Equipment

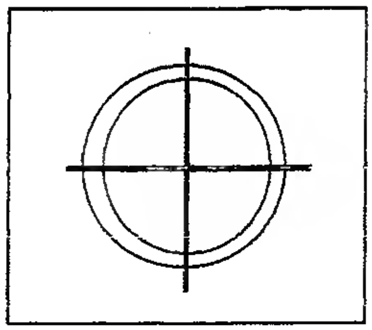
Sodium Thiosulfate, 0.08 M (2%)
Hydrochloric acid, 2M,20%
Distilled water,
Measuring Cylinders, 10ml, 25ml and 100ml
Conical Flask, 150ml
Stop watch
watch glass
Beaker, 400ml

Procedure

Mark a black cross on a piece of paper.
Place the beaker over the paper.
Add 100mls of ice water to the beaker.
Add 45ml of the thiosulfate solution to the conical flask.
After 5 minutes measure and record the temperature.
Measure 5mls of the acid.
Start the stop watch as the acid is added to the flask.
Swirl the flask and place the watch glass over the flask mouth.

Record the time at which the black cross can no longer be seen through the solution.
Empty the solution into a waste flask in a fume hood.
Rinse the the flask thoroughly.
Repeat the above steps four times, each time increasing the temperature of the beaker water by 15 degrees.
Plot the results on a graph of Temperature (degrees Kelvin) versus the reciprocal of reaction time.





Result: increasing the temperature increased the rate of reaction.

Conclusion: The rate of a reaction is proportional to the temperature of the reaction in degrees kelvin.

Risk Level: Mild Hazard: The reaction of sodium thiosulfate and hydrochloric acid produces colloidal sulfur (see Sunset reaction) and sulfur dioxide. While predominately the sulfur dioxide dissolves in the solution, care should be taken in disposing of the mixture as the fumes are harmful if inhaled. Hydrochloric acid is corrosive and any contact with skin should be treated with vigorous washing.

STUDENT: ____________________

154

Rebreathing

Aim: To determine the physiological response of rebreathing exhaled air.

Equipment

Plastic bag

Stop watch

Procedure

A volunteer commences breathing in and out of a plastic bag. The number of breaths in each thirty seconds is recorded.

Time	Breaths
30sec	
60sec	
90sec	
120sec	
150sec	
180sec	
210sec	

Results: ____

____

____

Conclusion: ____

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154

Rebreathing

Topics: Respiration Coordination

Aim: To determine the physiological response of rebreathing exhaled air.

Equipment

Plastic bag

Stop watch

Procedure

A volunteer commences breathing in and out of a plastic bag. The number of breaths in each thirty seconds is recorded.

Result: As carbon dioxide levels elevate in the rebreathed air, carbon dioxide levels also elevate in the blood. The physiological response is more and more rapid breathing.

Conclusion: The human body lacks blood monitors for oxygen but does have blood monitors for carbon dioxide. When carbon dioxide rises in the blood a stimulus is sent to the brain to breath faster to purge the waste gas and meet the perceived oxygen demand for higher activity. Hence panting after a sprint race. There is still plentiful oxygen in the bag.

Risk Level: Moderate Hazard: The subject should not continue the experiment to the point they feel distresses. Rebreathing is useful to control oxygen narcosis resulting from hyperventilation.

STUDENT:____________________

155

Red is Black

Aim: To investigate the phenomenon of colour.

Equipment

Plastic colour filters: Red, Blue, Green
Coloured Cardboard squares: White, Green, Red, Blue

Procedure

Construct a result table, filter colours at the top, colour squares down the side.
Using the Red filter, observe each of the colour squares and record the colour you see.
Repeat for each of the other colour filters.

Hint: Most colour squares are not pure, that is "red" is often a mixture of pigments and so a mixture of colours may be reflected.

Observed Colour

Card Colour	Red Filter	Green Filter	Blue Filter

Results: ____

____

____

Conclusion: ____

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155

Red is Black

Topics: Light

Aim: To investigate the phenomenon of colour.

Equipment

Plastic colour filters: Red, Blue, Green

Coloured Cardboard squares: White, Green, Red, Blue

Procedure

Construct a result table, filter colours at the top, colour squares down the side.

Using the Red filter, observe each of the colour squares and record the colour you see.

Repeat for each of the other colour filters.

Hint: Most colour squares are not pure, that is "red" is often a mixture of pigments and so a mixture of colours may be reflected.

Result: The red filter gave a red hue to the white card and red card, however the other colours appeared black. The same pattern occurred for the other filters with only the white card not appearing black through filters.

Conclusion: Red objects reflect red light but not other colours. A red filter allows the red light through. The green and blue filters do not let red light though and so the object appears black. white objects reflect all colours so the red light passes through the filter but not other colours.

Risk Level: Low Hazard

STUDENT:____________________

156 Refractive Index

Aim: To determine the Refractive Index of glass.

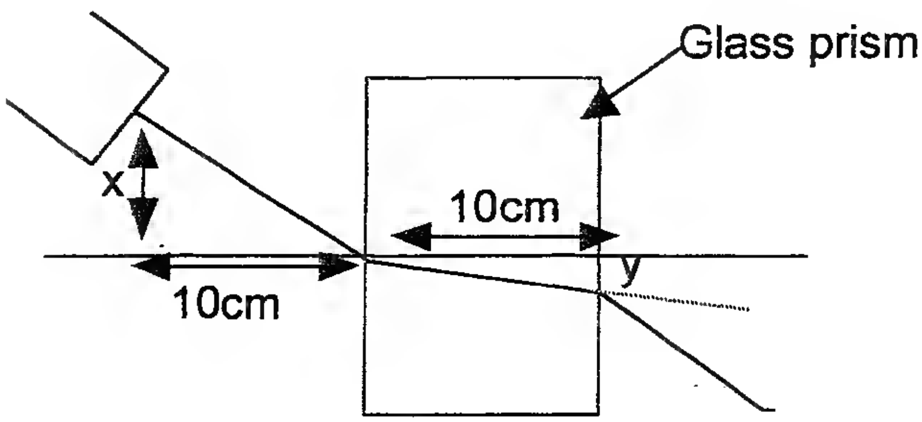
Equipment

Graph Paper 1mm grid
Glass Block
Hudson Ray Box
Power Supply, 12V DC

Procedure

Draw a vertical line in the centre of the graph paper.
Align the glass block on the paper so that the drawn line intersects at 90 degrees to one surface.
Connect the Ray Box to the power supply and project a single thin beam to strike the block where the drawn line meets the surface (the intersection point).
Mark the path of the beam on the paper (incident beam).
Mark where the beam leaves the glass (refracted beam).
Use a ruler to extend the incident and refracted beam lines from the incident point so each line is 10cm long.

At the 10cm mark measure how far each line is from your original straight line.
Divide the distance for the Incident line by the distance for the refracted line. This number is the refractive index of the glass.



Results: ____

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Conclusion: ____

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156

Refractive Index

Topics: Waves Light

Aim: To determine the Refractive Index of glass.

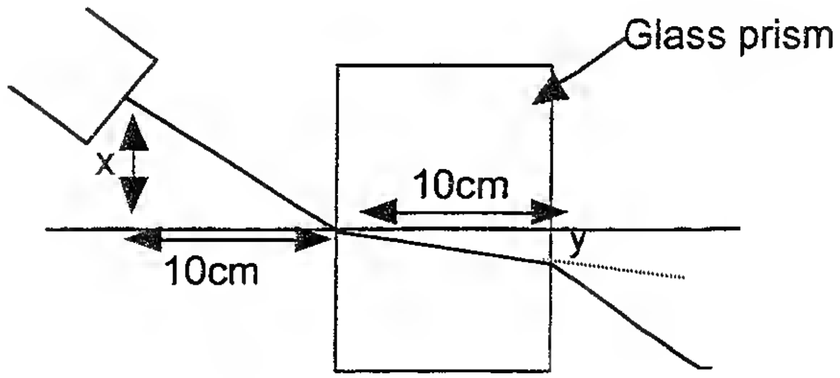
Equipment

Graph Paper 1mm grid
Glass Block
Hudson Ray Box
Power Supply, 12V DC

Procedure

Draw a vertical line in the centre of the graph paper.
Align the glass block on the paper so that the drawn line intersects at 90 degrees to one surface.
Connect the Ray Box to the power supply and project a single thin beam to strike the block where the drawn line meets the surface (the intersection point).
Mark the path of the beam on the paper (incident beam).
Mark where the beam leaves the glass (refracted beam).
Use a ruler to extend the incident and refracted beam lines from the incident point so each line is 10cm long.

At the 10cm mark measure how far each line is from your original straight line.
Divide the distance for the Incident line by the distance for the refracted line. This number is the refractive index of the glass.



Result: The path of the light beam bends toward the original straight line.

Conclusion: The refractive index is a measure of the bending of the light beam. Typical figures for glass are about 1.4.

Risk Level: Low Hazard

STUDENT:____________________

157

Respiration

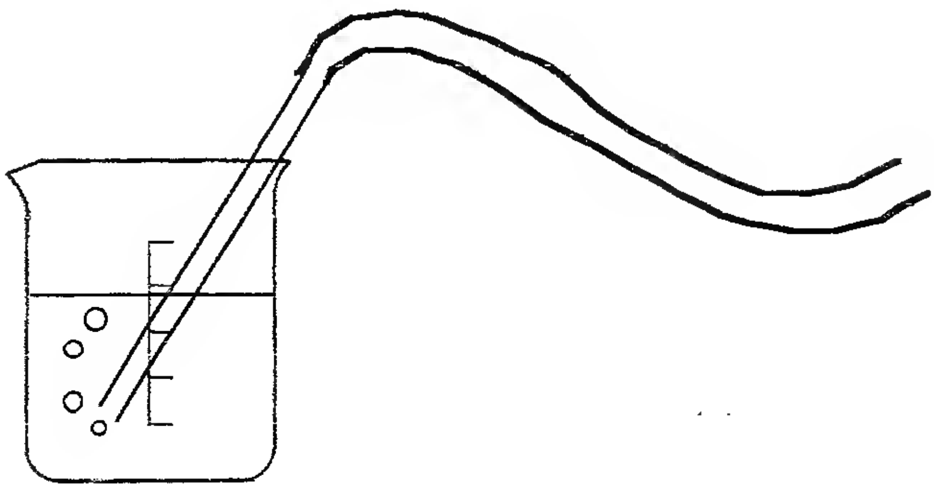
Aim: To test exhaled air for the presence of Carbon Dioxide

Equipment

Flexible hose connected to 10cm of glass tubing
Beaker, small
Lime Water: Pour 100g of Calcium hydroxide into a 5litre winchester. Fill with water, mix and allow to settle overnight. Pour off as needed, replacing lost water.

Procedure

Pour 30ml of Limewater into the beaker.
Bubble exhaled air into the limewater via the glass tube.



Results: ____

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Conclusion: ____

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157

Respiration

Topics: Energy in Life

Aim: To test exhaled air for the presence of Carbon Dioxide

Equipment

Flexible hose connected to 10cm of glass tubing
Beaker, small
Lime Water: Pour 100g of Calcium hydroxide into a 5litre winchester. Fill with water, mix and allow to settle overnight. Pour off as needed, replacing lost water.

Procedure

Pour 30ml of Limewater into the beaker.
Bubble exhaled air into the limewater via the glass tube.

Result: A white precipitate forms in the beaker.

Conclusion: Limewater is saturated calciuim hydroxide solution. Carbon dioxide is converted into insoluble carbonate, creating a precipitate.

Risk Level: Low

STUDENT: ____________________

158

Respiration 2

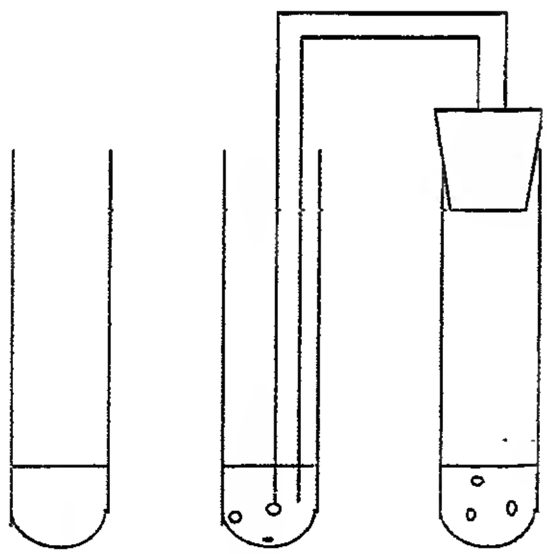
Aim: To Observe that respiration involves the breakdown of sugars into carbon dioxide.

Equipment

Glucose powder
Yeast powder
Test tubes, 3
Stopper with delivery tube
Limewater
Beaker, 250ml

Procedure

Add a spatula of yeast powder to two test tubes.
Add a spatula of glucose powder to one tube.
Half fill each test tube and the beaker with warm water.
Place the tubes in the beaker.
Half fill the third test tube with Limewater.
After about 20 minutes one of the tubes will be bubbling.
Use the stopper and delivery tube to bubble this gas into the limewater.



Results: ____________________

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Conclusion: ____________________

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158

Respiration 2

Topics: Biological Chem Energy in Life

Aim: To Observe that respiration involves the breakdown of sugars into carbon dioxide.

Equipment	**Procedure**
Glucose powder	Add a spatula of yeast powder to two test tubes.
Yeast powder	Add a spatula of glucose powder to one tube.
Test tubes, 3	Half fill each test tube and the beaker with warm water.
Stopper with delivery tube	Place the tubes in the beaker.
Limewater	Half fill the third test tube with Limewater.
Beaker, 250ml	After about 20 minutes one of the tubes will be bubbling.
	Use the stopper and delivery tube to bubble this gas into the limewater.

Result: The tube containing yeast and glucose produced a gas which turned limewater cloudy.

Conclusion: Yeast converts glucose into carbon dioxide and water by respiration (and anaerobic fermentation).

Risk Level: Low Hazard

STUDENT:____________________

159

Seed Needs

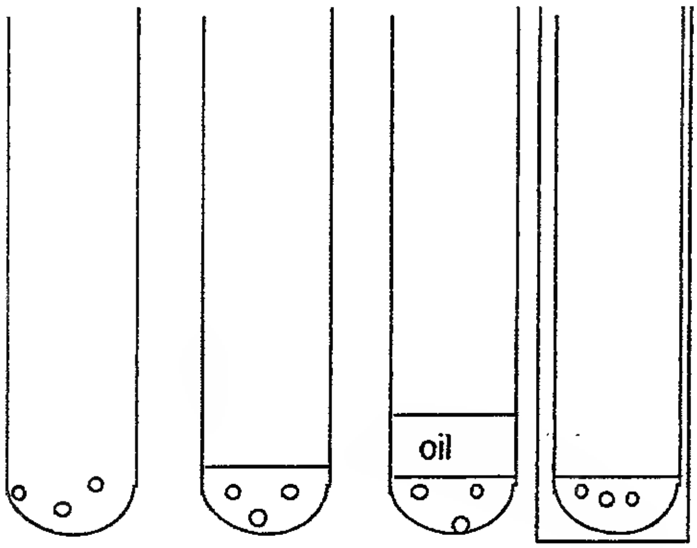
Aim: To determine the basic requirements for the growth of radish seeds.

Equipment

Radish seeds
test tubes,4
Olive oil

Procedure

Add three seeds to each test tube.
Add 1cm of water to one tube.
Add nothing to one tube, that is, no water.
Add 1cm of degassed water to one tube and 1cm of Olive oil on top, to exclude air.
Add 1cm of water to one tube then wrap in alfoil to exclude all light.
Leave in a warm place for 7 days
Record which tubes contain sprouted seeds.



Results: ____

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Conclusion: ____

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159

Seed Needs

Topics: Plants

Aim: To determine the basic requirements for the growth of radish seeds.

Equipment

Radish seeds
test tubes,4
Olive oil

Procedure

Add three seeds to each test tube.
Add 1cm of water to one tube (positive control).
Add nothing to one tube, that is, no water.
Add 1cm of degassed water to one tube and 1cm of Olive oil on top, to exclude air.
Add 1cm of water to one tube then wrap in alfoil to exclude all light.
Leave in a warm place for 7 days
Record which tubes contain sprouted seeds.

Result: The seeds germinated and grew in the tubes with 2cm of water with or without alfoil.

Conclusion: Radish seeds will grow with or without light, but will not grow without either water or air

Risk Level: Low Hazard

STUDENT:____________________

160 Seeing Ions

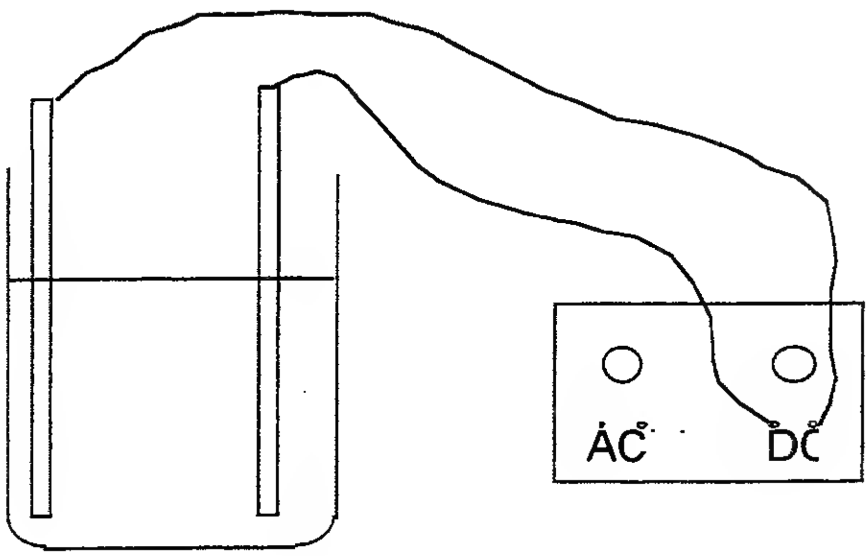
Aim: To visually observe ions forming at the electrodes of an electrochemical cell.

Equipment

Beaker, 100ml
carbon electrodes, two
Power Supply, 0-12V, DC
connecting leads, two
Potassium Iodide
0.1M,1.7%
Phenolphthalein,1%;
dissolve 5g of
Phenolphthalein in 250ml
Methylated Spirits, add
250ml of water and 2 drops
of sodium hydroxide 2M.

Procedure

Add 50ml of potassium iodide solution to the beaker.
Add 10 drops of Phenolphthaleine indicator and mix.
Insert the electrodes in the beaker so they do not touch.
Connect the wires to the DC terminals of the power supply.
Adjust the voltage to its lowest setting, 2V.
Turn on the power.
Draw the result on the diagram below.



Results: ____

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Conclusion: ____

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160

Seeing Ions

Topics: Ions Electricity

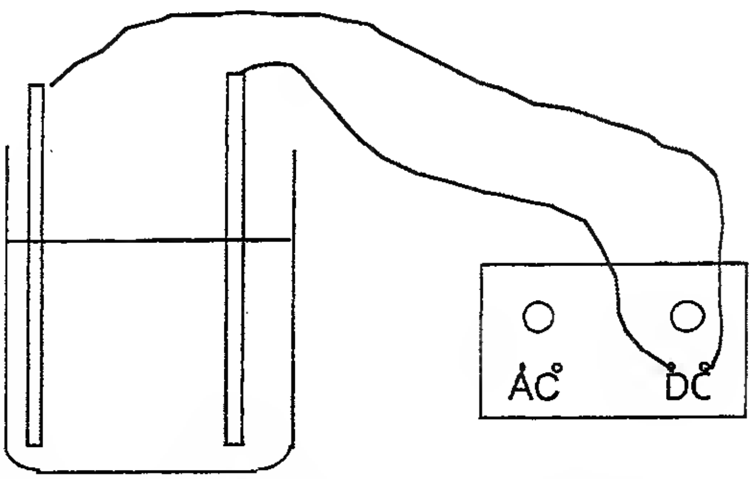
Aim: To visually observe ions forming at the electrodes of an electrochemical cell.

Equipment

Beaker, 100ml
carbon electrodes, two
Power Supply, 0-12V, DC
connecting leads, two
Potassium Iodide
0.1M,1.7%
Phenolphthalein,1%;
dissolve 5g of
Phenolphthalein in 250ml
Methylated Spirits, add
250ml of water and 2 drops
of sodium hydroxide 2M.

Procedure

Add 50ml of potassium iodide solution to the beaker.
Add 10 drops of Phenolphthaleine indicator and mix.
Insert the electrodes in the beaker so they do not touch.
Connect the wires to the DC terminals of the power supply.
Adjust the voltage to its lowest setting, 2V.
Turn on the power.



Result: A brown colour developed around the positive electrode (anode) while a red colour developed around the negative electrode (cathode).

Conclusion: At the anode brown Iodine is formed while the phenolphthalene reacts at the cathode due to generation of hydroxide ions.

Risk Level: Mild Hazard: Potassium Iodide is harmful if ingested.

STUDENT:____________________

161 Senses - Hearing

Aim: To determine the range and sensitivity of human hearing.

Equipment

Audio Oscillator
Power Supply, 12V, DC
Video Camera
TV and Video player
Towel or blanket

Procedure

1.Use the Audio oscillator to produce sounds from below. 50Hz to above 25000Hz to determine the range of human hearing. Remember, a sound is continuous, not a series of clicks.

Results: ____

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Conclusion: ____

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161

Senses - Hearing

Topics: Waves Coordination

Aim: To determine the range and sensitivity of human hearing.

Equipment

Audio Oscillator
Power Supply, 12V, DC
Video Camera
TV and Video player
Towel or blanket

Procedure

1.Use the Audio oscillator to produce sounds from below. 50Hz to above 25000Hz asking the students to hold up their hands whilever they can hear the sound.
Hint: hold your own hand up too, they will need a lead.

2.Set up the Video camera without telling the students what it is for and tape a few minutes of them talking.
Set up the video on the TV. Play it firstly with the screen covered by a towel or blanket.
Replay with the screen revealed.

Result: Most students cannot distinguish sounds below 50Hz or above 25000 Hz . Most of what was said on the video could not be understood with the screen covered but could be understood with the screen uncovered.

Conclusion: The Human Ear has a range between 50 and 25000 Hz. Dogs and bats can hear above 30000Hz. The human ear can focus on particular sounds eg a trumpet in a symphony. Even a speaker in a crowded room can be understood from all other voices provided the brain also receives visual clues to focus on. We do a lot of unconscious lip reading.

Risk Level: Low Hazard

STUDENT:________________

162

Soap

Aim: To produce soap from an oil and sodium hydroxide.

Equipment

Sodium Hydroxide
Castor or Coconut Oil
Beaker, 100ml
Bunsen, tripod, gauze
Sodium Chloride
BalanceFilter Paper
Glass rod
Spatula

Procedure

Weigh 6g of sodium hydroxide into the beaker.
Add 30ml of water.
Add 6 ml of oil.
Gently boil the mixture for 10 minutes while stirring, occasionally adding water to maintain the volume.
Add 10g of sodium chloride and boil while stirring for 2 min.
Decant the liquid and wash the precipitate twice with water.
Collect the precipitate onto a sheet of filter paper.
Place a sample of your precipitate into a test tube.
Add some water and shake.

Results: ____

____

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Conclusion: ____

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162

Soap

Topics: Organic Chem acids/bases Energy in Life

Aim: To produce soap from an oil and sodium hydroxide.

Equipment

Sodium Hydroxide
Castor or Coconut Oil
Beaker, 100ml
Bunsen, tripod, gauze
Sodium Chloride
BalanceFilter Paper
Glass rod
Spatula

Procedure

Weigh 6g of sodium hydroxide into the beaker.
Add 30ml of water.
Add 6 ml of oil.
Gently boil the mixture for 10 minutes while stirring, occasionally adding water to maintain the volume.
Add 10g of sodium chloride and boil while stirring for 2 min.
Decant the liquid and wash the precipitate twice with water.
Collect the precipitate onto a sheet of filter paper.
Place a sample of your precipitate into a test tube.
Add some water and shake.

Result: The oil disappeared in the reaction however adding salt produced a precipitate which will froth when shaken with fresh water.

Conclusion: Oil + Sodium Hydroxide > Fatty Acid + Glycerol. Soaps are long chain fatty acids in a salt form. The fatty acid salt is insoluble in the presence of metal ions allowing the glycerol to be washed away.

Risk Level: HAZARDOUS: Concentrated sodium hydroxide is very caustic and will attack skin. Safety glasses should be worn as protection during the boiling phase. The soap produced should not be used on skin since it may retain sodium hydroxide. Any spills should be cleaned up using rubber gloves. Any contact with sodium hydroxide should be treated with prolonged washing in water.

STUDENT:____________________

163

Solubilities

Aim: To observe the solubilities of nitrates, chlorides, sulfates and carbonates in combination with different cations.

Equipment

Test Tube rack
Test tubes, four
Sodium Nitrate,0.1M(1%)
Sodium Chloride,0.1M(1%)
Sodium Sulfate, 0.1M(1%)
Sodium Carbonate,1%
Dropper Bottles of:
Potassium Nitrate,0.1M1%
Silver Nitrate, 0.1M (1%)
Lead Nitrate, 0.1M (3%)
Magnesium Sulfate,1%
Ferrous Sulfate, 0.1M (1%)
Copper Sulfate, 0.1 M (1%)
Barium Chloride. 0.1M(2%)
Calcium Chloride,0.1M 1%

Procedure

Add 1ml (twenty drops) of potassium nitrate to each test tube.
Add 1ml of sodium nitrate to the first tube, sodium chloride to the second, sodium sulfate to the third and sodium carbonate to the fourth.
Record any precipitates in a results table.
Empty and thoroughly rinse the test tubes.
Repeat the above steps for silver nitrate and for each of the other cation solutions.

Cations	Nitrate	Chloride	Sulfate	Carbonate
Potassium				
Silver				
Lead				
Magnesium				
Iron				
Copper				
Barium				
Calcium				

Results: ____

____

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Conclusion: ____

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163

Solubilities

Topics: Equilibrium Solubilities

Aim: To observe the solubilities of nitrates, chlorides, sulfates and carbonates in combination with different cations.

Equipment

Test Tube rack
Test tubes, four
Sodium Nitrate,0.1M(1%)
Sodium Chloride,0.1M(1%)
Sodium Sulfate, 0.1M(1%)
Sodium Carbonate,1%
Dropper Bottles of:
Potassium Nitrate,0.1M1%
Silver Nitrate, 0.1M (1%)
Lead Nitrate, 0.1M (3%)
Magnesium Sulfate,1%
Ferrous Sulfate, 0.1M (1%)
Copper Sulfate, 0.1 M (1%)
Barium Chloride. 0.1M(2%)
Calcium Chloride,0.1M 1%

Procedure

Add 1ml (twenty drops) of potassium nitrate to each test tube.
Add 1ml of sodium nitrate to the first tube, sodium chloride to the second, sodium sulfate to the third and sodium carbonate to the fourth.
Record any precipitates in a results table.
Empty and thoroughly rinse the test tubes.
Repeat the above steps for silver nitrate and for each of the other cation solutions.

Nitrate to nitrate combinations are Controls.

Result: No precipitates formed with Nitrates but sulfates, chlorides and carbonates produced precipitates with various cations, particularly the heavier metals.

Conclusion: All nitrates are soluble. Most sulfates are soluble except barium, silver and lead. Chlorides are soluble except for lead, silver, copper, and barium. Most carbonates are insoluble.

Risk Level: Moderate Hazard: Lead and silver nitrate are highly toxic and should be handled with care. Silver nitrate causes black skin stains. All the other solutions and precipitates should be considered as harmful if ingested or splashed in the eyes.

STUDENT:____________________

164

Solvents

Aim: To compare the properties of Polar and Non-polar solvents.

Equipment

Test Tube Rack
Test tubes, nine
Beaker, 100ml
Distilled Water
Kerosene
Sodium Chloride
Copper Sulfate
Sodium Carbonate
sucrose
urea
ethanol
Iodine
Naphthalene
Oil

Procedure

Place 5ml of water in each test tube.
Add a few crystals of sodium chloride to the first test tube
Repeat with the other test tubes, each with a different solute (add 0.5ml in the case of ethanol).
Shake each tube and record which solutes dissolved.
Empty and clean the test tubes, drying briefly over a Bunsen if necessary.
Add 5ml of kerosene to each test tube and test each of the solutes as before.
Record which solutes dissolved.

Empty the test tubes into a waste bottle and then clean using detergent.
Notes: Ionic solutes; sodium chloride, copper sulfate, sodium carbonate.
Polar covalent Solutes; urea, sucrose, ethanol
Non-polar covalent solutes; iodine, oil, napthalene

Solute	Water	Kerosine
Sodium Chloride		
Copper Sulfate		
Sodium Carbonate		
Sucrose		
Urea		
Ethanol		
Iodine		
Napthaleine		
Oil		

Results: ____

____

____

Conclusion: ____

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164

Solvents

Topics: Solubility Ions Chemistry

Aim: To compare the properties of Polar and Non-polar solvents.

Equipment

Test Tube Rack
Test tubes, nine
Beaker, 100ml
Distilled Water
Kerosene
Sodium Chloride
Copper Sulfate
Sodium Carbonate
sucrose
urea
ethanol
Iodine
Naphthalene
Oil

Procedure

Place 5ml of water in each test tube.
Add a few crystals of sodium chloride to the first test tube
Repeat with the other test tubes, each with a different solute (add 0.5ml in the case of ethanol).
Shake each tube and record which solutes dissolved.
Empty and clean the test tubes, drying briefly over a Bunsen if necessary.
Add 5ml of kerosene to each test tube and test each of the solutes as before.
Record which solutes dissolved.

Empty the test tubes into a waste bottle and then clean using detergent.
Notes: Ionic solutes; sodium chloride, copper sulfate, sodium carbonate.
Polar covalent Solutes; urea, sucrose, ethanol
Non-polar covalent solutes; iodine, oil, napthalene

Result: Ionic and polar covalent compounds are soluble in water. Polar covalent and non- polar covalent compounds are soluble in kerosene.

Conclusion: Water is a polar solvent while kerosene is a non-polar solvent. Only polar covalent compounds are soluble in both types of solvents.

Risk Level: Moderate Hazard: Ethanol , napthalene, kerosene and oil are flammable and must be kept away from any flames.

STUDENT:____________________

165 Sound Cannon

Aim: To demonstrate that sound is a pressure wave.

Equipment

20 litre plastic drum and lid

Procedure

Cut a 7cm circular hole in the base of the drum.
Crush a sheet of waste paper into a loose ball and place it on a table two metres away.
Demonstrate you cannot blow the paper away.
Aim the long axis of the drum toward the paper, hole forwards.
Strike the lid firmly with your hand.

Proceed to "shoot" every student in the class.

Results: ____

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Conclusion: ____

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165

Sound Cannon

Topics: Waves

Aim: To demonstrate that sound is a pressure wave.

Equipment

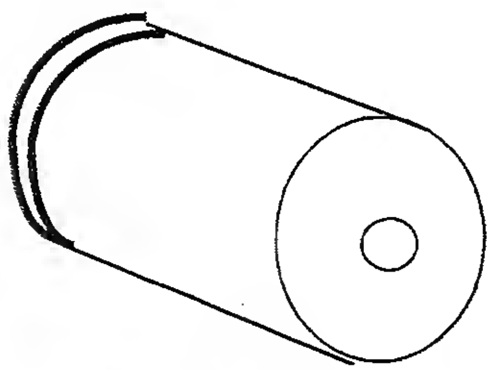
20 litre plastic drum and lid

Procedure

Cut a 7cm circular hole in the base of the drum.
Crush a sheet of waste paper into a loose ball and place it on a table two metres away.
Demonstrate you cannot blow the paper away (control).
Aim the long axis of the drum toward the paper, hole forwards.
Strike the lid firmly with your hand.

Proceed to "shoot" every student in the class.

Sound Cannon



Result: The pressure wave from the sound cannon can easily move the paper at up to four metres distance.

Conclusion: Sound is a pressure wave in air.

Risk Level: Low Hazard

STUDENT:__________________

166

Spectrum Clock

Aim: To observe a sequential reaction which causes pH changes at a definite rate.

Equipment

Sodium Thiosulfate
Acetic Acid 0.1M (0.7%)
Potassium Iodide
Hydrogen Peroxide, 6%
Universal indicator
Measuring Cylinder, 100ml
Beaker 250ml

Procedure

Solution A: Dissolve 0.372g sodium thiosulfate in 200mls water. Dissolve 9g of potassium iodide in a separate 200mls of water. Mix both together in a large beaker. Add 4ml of 0.1M Acetic acid then add water to adjust the total volume to 500ml. Measure 100ml of solution A into a 250ml beaker and mix in 10 drops of universal indicator.
Freshly prepare 0.05M hydrogen peroxide by diluting 7ml of 6% solution to 250ml with water.
Mix 30ml of this solution with the 100ml of solution A.

Time the colour changes.
Repeat the experiment adding only half the amount of hydrogen peroxide 0.05M.

Results: ______________________________

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Conclusion: ______________________________

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166

Spectrum Clock

Topics: Chemical Rns Reaction Rates Acids and Bases

Aim: To observe a sequential reaction which causes pH changes at a definite rate.

Equipment

Sodium Thiosulfate
Acetic Acid 0.1M (0.7%)
Potassium Iodide
Hydrogen Peroxide, 6%
Universal indicator
Measuring Cylinder, 100ml
Beaker 250ml

Procedure

Solution A: Dissolve 0.372g sodium thiosulfate in 200mls water. Dissolve 9g of potassium iodide in a separate 200mls of water. Mix both together in a large beaker. Add 4ml of 0.1M Acetic acid then add water to adjust the total volume to 500ml.
Measure 100ml of solution A into a 250ml beaker and mix in 10 drops of universal indicator.
Freshly prepare 0.05M hydrogen peroxide by diluting 7ml of 6% solution to 250ml with water.
Mix 30ml of this solution with the 100ml of solution A.

Time the colour changes.
Repeat the experiment adding only half the amount of hydrogen peroxide 0.05M.
Adding water instead of hydrogen peroxide would be a "control".

Result: The reaction mixture changes colour approximately every five seconds in a spectrum from orange to purple. Reducing the amount of peroxide slowed the rate of reaction.

Conclusion: The reaction proceeds in several steps which withdraw hydrogen ions from solution and thereby raises the pH as shown by the colour changes. Reducing the concentration of peroxide in the mixture slows the primary reaction and the colour changes.

Risk Level: Mildly Hazardous: Hydrogen peroxide 6% is an oxidising agent and should be isolated from flammable liquids or other oxidising agents. Hydrogen peroxide can be irritating to the skin and should not be ingested. Students should not prepare acetic acid from the concentrate Sulfur Dioxide is produced in the reaction and disposal should be done in a fume hood sink.

STUDENT:________________

167 # Speed of Sound

Aim: To measure the speed of sound.

Equipment

Metal Trash Can
Stop Watches
Trundle Wheel Measure

Procedure

Measure out 100m on the sports oval.
At one extreme is a student with the trash can who, with exaggerated movement strikes the can with the lid.
Students with stop watches stand at the other extreme and record the time between seeing the lid strike and hearing it strike.

Results: ____

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Conclusion: ____

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167

Speed of Sound

Topics: Waves

Aim: To measure the speed of sound.

Equipment

Metal Trash Can
Stop Watches
Trundle Wheel Measure

Procedure

Measure out 100m on the sports oval.
At one extreme is a student with the trash can who, with exaggerated movement strikes the can with the lid.
Students with stop watches stand at the other extreme and record the time between seeing the lid strike and hearing it strike.

Result:

Conclusion: Velocity of Sound = 100/ Average Time.
Approximately 330 metres per second.

Risk Level: Low Hazard

STUDENT:____________________

168

States of Iodine

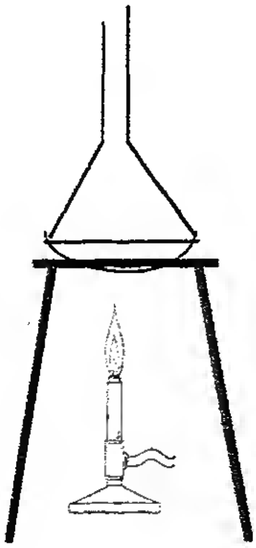
Aim: To observe the sublimation of iodine from solid to liquid and back.

Equipment

Iodine Crystals
Filter Funnel
Evaporating Basin
Filter Paper
Tripod and Bunsen
tweezers

Procedure

Place a few iodine crystals in the evaporating basin using tweezers.
Place a disk of filter paper over the crystals and invert a filter funnel over all.
In a fume hood; Place the evaporating basin on a tripod and heat gently with a Bunsen.



Results: ____

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Conclusion: ____

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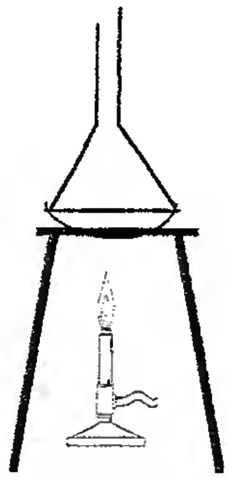
168

States of Iodine

Topics: Matter States of Matter Elements

Aim: To observe the sublimation of iodine from solid to liquid and back.

Equipment	**Procedure**
Iodine Crystals Filter Funnel Evaporating Basin Filter Paper Tripod and Bunsen tweezers	Place a few iodine crystals in the evaporating basin using tweezers. Place a disk of filter paper over the crystals and invert a filter funnel over all. In a fume hood; Place the evaporating basin on a tripod and heat gently with a Bunsen.



Result: A purple vapour appears in the filter funnel and black crystals condense on the glass.

Conclusion: Iodine crystals sublime into purple gas when heated and the gas recondenses to black crystals on the glass.

Risk Level: Moderate Hazard: Recommended as a Demonstration. Iodine can be harmful if ingested in quantity and may react powerfully with reducing agents. Iodine will stain the skin if handled. Iodine vapours should be avoided by use of a fume hood.

STUDENT:

169

Stomates

Aim: To observe and determine the function of stomates

Equipment

Geranium cuttings (fresh)
Microscope
Gas Jar
Petroleum Jelly
Saffranine 0.3%

Procedure

Examine a geranium leaf under a microscope at low power for stomate openings on the upper and lower surfaces.
Draw some stomates as they appear through the microscope.
Coat the lower surfaces of some leaves on a cutting with petroleum jelly.
Stand the cutting overnight in a gas jar with 100mls of Saffranine solution.

Results:

Conclusion:

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169

Stomates

Topics: Plants

Aim: To observe and determine the function of stomates

Equipment

Geranium cuttings (fresh)
Microscope
Gas Jar
Petroleum Jelly
Saffranine 0.3%

Procedure

Examine a geranium leaf for stomate openings on the upper and lower surfaces.
Coat the lower surfaces of some leaves on a cutting with petroleum jelly.
Stand the cutting overnight in a gas jar with 100mls of Saffranine solution.

Result: Many more stomates were observed on the lower leaf surface.
Leaves coated with petroleum jelly did not become stained with dye while the other leaves stained red.

Conclusion: Stomates are essential to allow a plant to evaporate the water drawn up through its Xylem vessels. If the stomates are blocked, Xylem flow stops.

Risk Level: Low Hazard

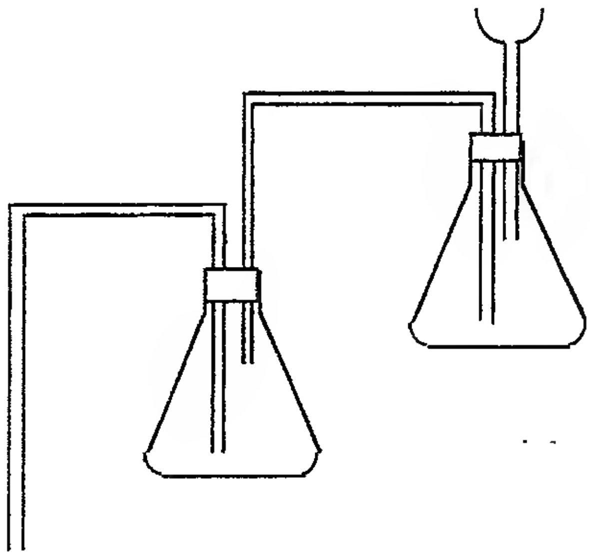
STUDENT:________________

170 Suction Fiction

Aim: To prove that the concept of "suction" (pulling a liquid or gas) is false.

Equipment
Beaker, 250ml
Glass tube, 10mm by 20cm
Air blower
Venturi pump
Conical Flasks, 500ml, 2
Stoppers, 2,double holed
Glass tubing, 8mm, two
(U-shape,30,20,10cm),
Retort stand and clamp
Thistle funnel

Procedure
1/ Partly fill a beaker with water.
Insert a glass tube (10mm by 20cm) vertically in the water.
Using the blower, direct an air stream horizontally over the tube mouth.
2/ Use the same air blower through a venturi pump and show that one outlet hose draws water from a beaker.
3/ Demonstrate the same effect with water flow from a tap.
4/ What happens in the apparatus drawn below.



Results: ____

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Conclusion: ____

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170

Suction Fiction

Topics: Density/ Pressure Water

Aim: To prove that the concept of "suction" (pulling a liquid or gas) is false.

Equipment

Beaker, 250ml
Glass tube, 10mm by 20cm
Air blower
Venturi pump
Conical Flasks, 500ml, 2
Stoppers, 2,double holed
Glass tubing, 8mm, two (U-shape,30,20,10cm),
Retort stand and clamp
Thistle funnel

Procedure

Invite a student to pull water out of a beaker with their fingers. Impossible!

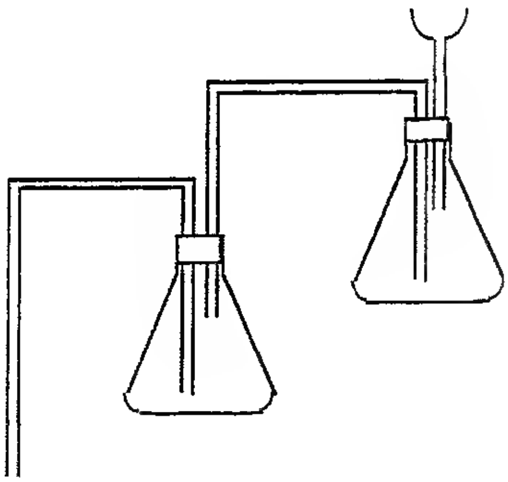
1/ Partly fill a beaker with water.
Insert a glass tube (10mm by 20cm) vertically in the water.
Using the blower, direct an air stream horizontally over the tube mouth.

2/ Use the same air blower through a venturi pump and show that one outlet hose draws water from a beaker.

3/ Demonstrate the same effect with water flow from a tap.

4/ Set up two conical flasks next to a sink.

Insert U - shape tubing carefully into the stoppers as in the diagram below.
Partly fill both conical flasks with water.
Add water to the thistle funnel until siphon begins.



Result:

Conclusion: Suction is supposed to act by drawing water or air, however the air pump activities show water being draw by blowing. When air or liquid velocity is increased a low pressure area is created and the surrounding high pressure pushes water into the tube. In the glass double siphon, suction is clearly fiction as it requires air to "stick to" water.

Risk Level: Mild Hazard: Have some narrow gauge plastic tubing on hand to repair your glass U- tubes if one should break . Only the teacher or Lab assistant should fit the glass tubing in the stoppers and with great care. Students are likely to spear themselves with broken tubing.

STUDENT:____________________

171

Sunset Expt.

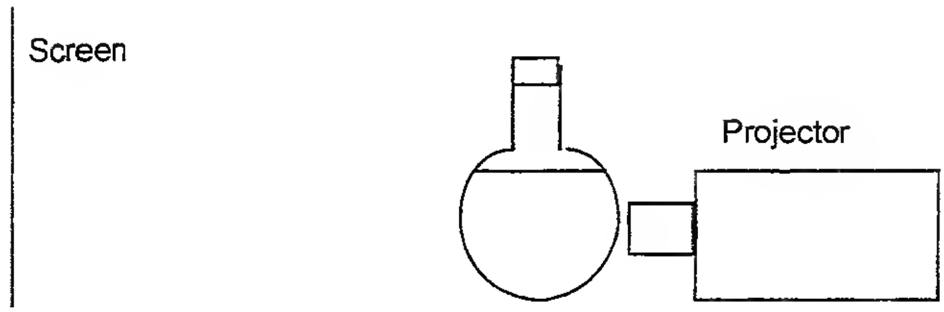
Aim: To recreate the conditions which demonstrate why the sky is blue and polarised, while sunsets are red and unpolarised.

Equipment

Sodium Thiosulfate
Hydrochloric Acid 1M, 10%
Large Round Bottom or Florence Flask, 500ml - 1L
Powerful light eg projector
Polarising Sheets

Procedure

Dissolve sodium thiosulfate to approximately 2%, sufficient to nearly fill the flask.
Mount the flask directly in front of the projector and so the beam plays onto a screen.
Darken the room.
Add 20ml of the acid and stir briefly.
Observe the beam in the flask and the light on the screen through a polarised sheet. Turn the sheet through 90 degrees.



Results: ____

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Conclusion: ____

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171

Sunset Expt.

Topics: Waves   Wave Prop. Light   The Sky

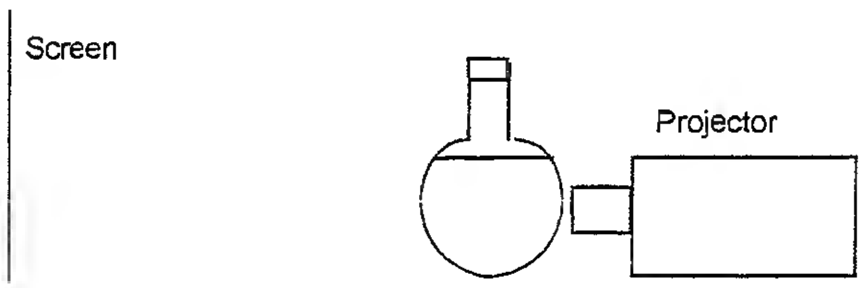
Aim: To recreate the conditions which demonstrate why the sky is blue and polarised, while sunsets are red and unpolarised.

Equipment

Sodium Thiosulfate
Hydrochloric Acid 1M, 10%
Large Round Bottom or Florence Flask, 500ml - 1L
Powerful light eg projector
Polarising Sheets

Procedure

Dissolve sodium thiosulfate to approximately 2%, sufficient to nearly fill the flask.
Mount the flask directly in front of the projector and so the beam plays onto a screen.
Darken the room.
Add 20ml of the acid and stir briefly.
Observe the beam in the flask and the light on the screen through a polarised sheet. Turn the sheet through 90 degrees.



Result: The solution gradually becomes blue/white, the light being strongly polarised when viewed at right angles to the beam. The transmitted light fades to yellow, orange and finally red, all of which are unpolarised.

Conclusion: The reaction produces colloidal sulfur which scatters light in much the same way as particles in the atmosphere. Higher frequency, short wavelengths (blue light) are more prone to the scattering, leaving the longer red wavelengths to penetrate. Scattered light is polarised while the transmitted light remains unpolarised.

Risk Level: Mild Hazard: Hydrochloric acid 1M is mildly corrosive and any skin contact should be treated with vigorous washing. Sulfur dioxide is produced in the reaction but remains mostly in solution, nevertheless dispose of the solution in the fume cupboard.

STUDENT: ____________________

172 Sunspots

Aim: To observe the storms on the surface of stars known as sun spots.

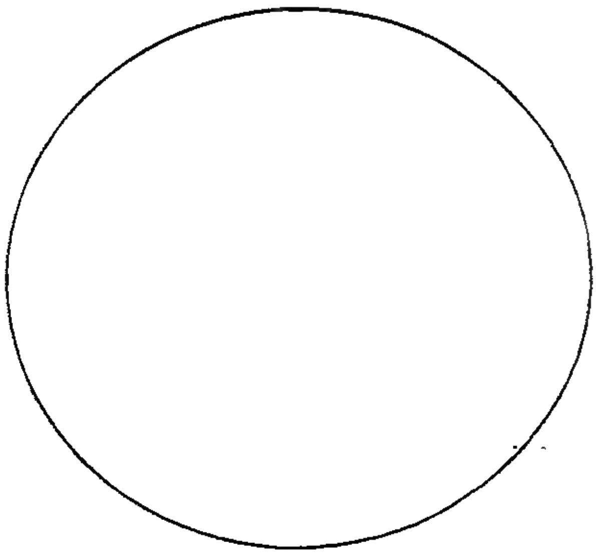
Equipment

Binoculars
Retort stand and clamp
Sheets of white card, two
sticky tape

Procedure

Choose a day when the sun is low in the morning or afternoon ie winter. Focus the binoculars to infinity.
Cut a hole in the centre of one card to fit one of the binocular lenses and stick it in place.
Support the binoculars with the retort stand so they are facing the sun ie sharp rectangular shadow of the card.
Holding the second card parallel to the first, slowly move between 2 and 6m behind the binoculars keeping the shadow of the binoculars on the card.
At the correct focal point a sharp image of the sun appears.

In the space, below draw the image of the sun.



Results: ____

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Conclusion: ____

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172

Sunspots

Topics: Universe The Sky

Aim: To observe the storms on the surface of stars known as sun spots.

Equipment

Binoculars
Retort stand and clamp
Sheets of white card, two
sticky tape

Procedure

Choose a day when the sun is low in the morning or afternoon ie winter. Focus the binoculars to infinity.
Cut a hole in the centre of one card to fit one of the binocular lenses and stick it in place.
Support the binoculars with the retort stand so they are facing the sun ie sharp rectangular shadow of the card.
Holding the second card parallel to the first, slowly move between 2 and 6m behind the binoculars keeping the shadow of the binoculars on the card.
At the correct focal point a sharp image of the sun appears.

Result: Dark blotches could be seen on the face of the sun.

Conclusion: Storms on the Sun are seen as dark spots since these storms are at a lower temperature (and less luminous) than the 6000 degrees centigrade of the rest of the photosphere.

Risk Level: mild hazard: DO NOT LOOK AT THE SUN DIRECTLY THROUGH THE BINOCULARS.

STUDENT:____________________

173 # Super Balloons

Aim: To demonstrate that pressure is force applied over an area. A large force over a large area yields only a small pressure.

Equipment	**Procedure**
Five Party Balloons	Sweep an area of the floor clean. Half inflate the balloons and arrange them on the floor. Wipe down a table and then invert it onto the balloons. See how many students can stand on the table without bursting the balloons. Draw the experiment in the space below.

Results: ____

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Conclusion: ____

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173

Super Balloons

Topics: Density/ Pressure

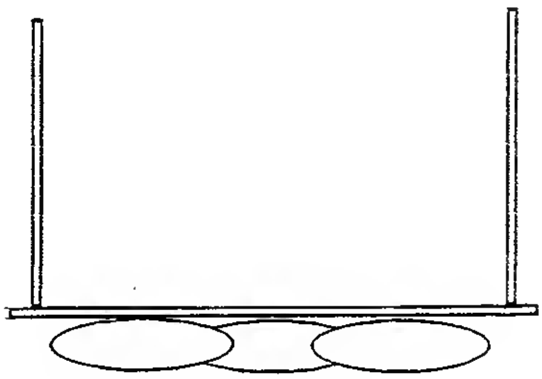
Aim: To demonstrate that pressure is force applied over an area. A large force over a large area yields only a small pressure.

Equipment

Five Party Balloons

Procedure

Sweep an area of the floor clean.
Half inflate the balloons and arrange them on the floor.
Wipe down a table and then invert it onto the balloons.
See how many students can stand on the table without bursting the balloons.



Result: The balloons flatten but do not burst.

Conclusion: The weight of the students is spread over the area of the table so the pressure applied to the balloons is insufficient to cause them to burst.

Risk Level: Mild Hazard: Beware of students "accidentally" falling since the up-ended table legs could be dangerous.

STUDENT:____________________

174 Super Induction

Aim: To demonstrate that a moving magnet can generate counter magnetic fields in non-magnetic conductors.

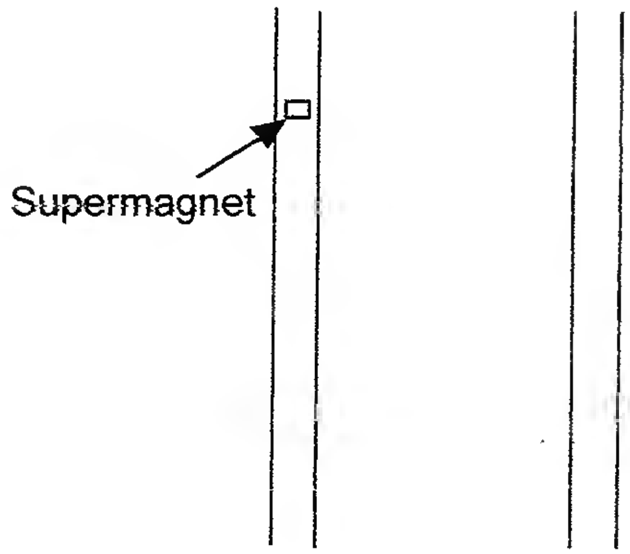
Equipment

Plastic Tube, 1m
Aluminium Tube, 1m
Super magnet disk

Procedure

Drop the magnet though the plastic tube.
Check that the the magnet is not attracted to the aluminium tube.
Drop the magnet through the aluminium tube.

NOTE: You must catch the magnet before it falls to the floor. Supermagnets are brittle and may shatter if they strike a hard surface.



Results: ____

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Conclusion: ____

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174

Super Induction

Topics: Electromagnetism

Aim: To demonstrate that a moving magnet can generate counter magnetic fields in non-magnetic conductors.

Equipment

Plastic Tube, 1m
Aluminium Tube, 1m
Super magnet disk

Procedure

Drop the magnet though the plastic tube (control).
Demonstrate the the magnet is not attracted to the aluminium tube.
Drop the magnet through the aluminium tube.

Result: The magnet falls easily through the plastic tube but slowly floats down the aluminium tube.

Conclusion: The falling magnet induces electrical local currents in the aluminium tube (conductor in a moving magnetic field). The induced current creates a magnetic field of opposite polarity to the super magnet thereby resisting its fall.

Risk Level: Low Hazard: Keep the super magnet well away from computers, floppy disks, videos or any other magnetic storage device.

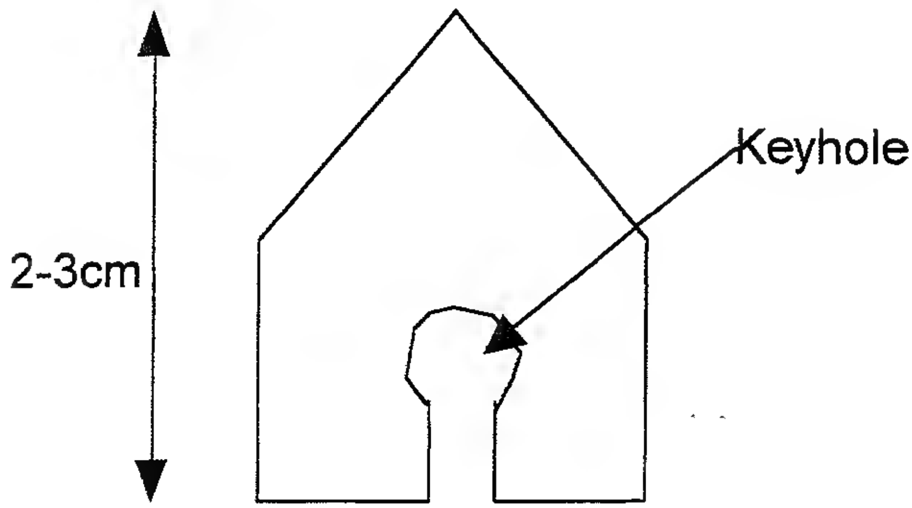
STUDENT:________________

175 Surface Tension Boats

Aim: To investigate the surface tension properties of water.

Equipment
Large plastic trays
Scissors
Grease Proof Paper
Dropper Bottles
Methylated Spirits

Procedure
Students are to cut boat shapes out of grease proof paper (see diagram below).
The "boats" are floated on the surface of water in the plastic trays.
Drops of methylated spirits are placed in the "keyhole" using a dropper bottle..



Results: ____

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Conclusion: ____

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175

Surface Tension Boats

Topics: Water How atoms Join

Aim: To investigate the surface tension properties of water.

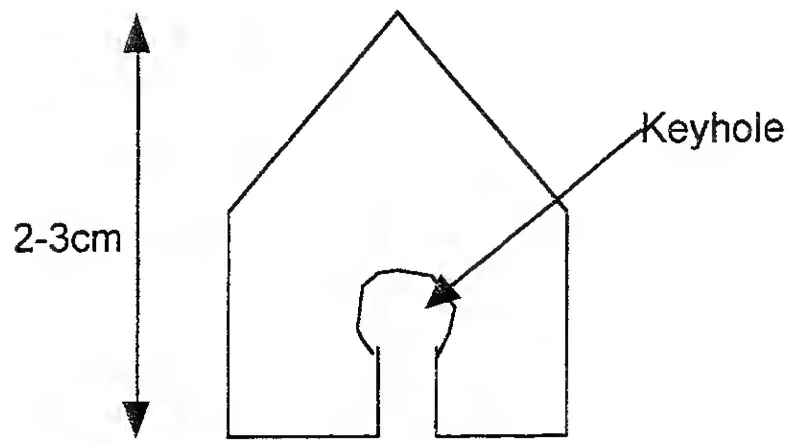
Equipment

Large plastic trays
Scissors
Grease Proof Paper
Dropper Bottles
Methylated Spirits

Procedure

Students are to cut boat shapes out of grease proof paper (see diagram below).
The "boats" are floated on the surface of water in the plastic trays.
Drops of methylated spirits are placed in the "keyhole" using a dropper bottle..

Using water in the dropper bottle would be a "control".



Result: The boats spurt forward over the surface.

Conclusion: Methylated Spirits has a low surface tension compared to water. The effect of adding drops of methylated spirits is like a tearing the stretched surface of a balloon.

Risk Level: Very Low Hazard

STUDENT:____________________

176 Suspension Bridge

Aim: To investigate the relationship between vector components and the tension in a horizontal string supporting a mass.

Equipment

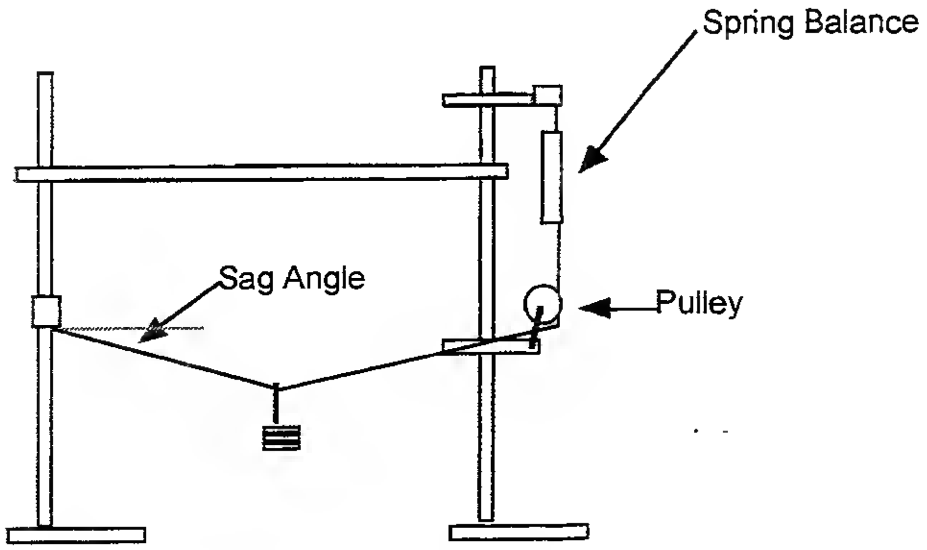
- Retort Stands, 3
- clamps and boss heads, 4
- Single pulley clamp
- string, 1m
- spring balance, 5N
- mass carrier.
- masses
- protractor

Procedure

Set up two retort stands about 50cm apart.
Unscrew the rod from a third stand and mount it at the top on boss head clamps between the two stands.
About 20cm from the base of each stand, mount clamps.
A string is run from the left clamp to a pulley mounted on the right clamp and then upwards to a spring balance supported on the horizontal beam.
Hang the mass carrier in the middle of the horizontal span of string.

Record the sag angle of the string and the tension on the spring balance.
Add a 50g mass to the carrier.
Record the new sag angle and tension.

$$\sin\phi = 0.5mg / T ,$$



Results: ____

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Conclusion: ____

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176

Suspension Bridge

Topics: Forces

Aim: To investigate the relationship between vector components and the tension in a horizontal string supporting a mass.

Equipment

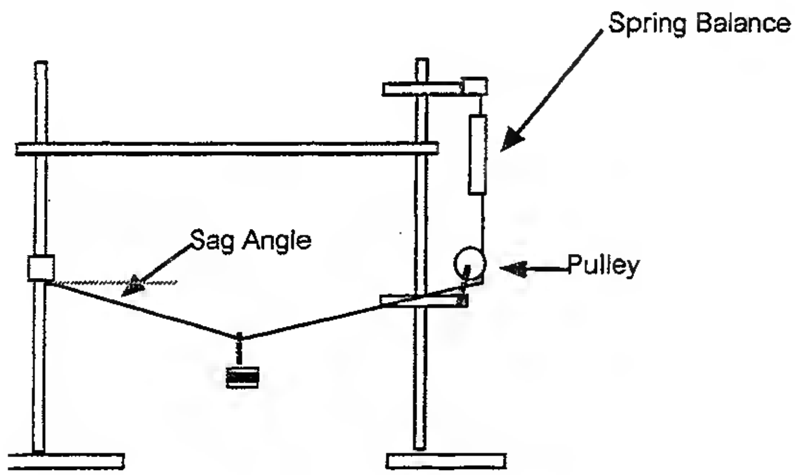
Retort Stands, 3
clamps and boss heads, 4
Single pulley clamp
string, 1m
spring balance, 5N
mass carrier.
masses
protractor

Procedure

Set up two retort stands about 50cm apart.
Unscrew the rod from a third stand and mount it at the top on boss head clamps between the two stands.
About 20cm from the base of each stand, mount clamps.
A string is run from the left clamp to a pulley mounted on the right clamp and then upwards to a spring balance supported on the horizontal beam.
Hang the mass carrier in the middle of the horizontal span of string.

Record the sag angle of the string and the tension on the spring balance.
Add a 50g mass to the carrier.
Record the new sag angle and tension.

$$\sin\phi = 0.5mg/T,$$



Result: Tension increases as the sag angle decreases.

Conclusion: The mass is supported by the vertical component of tension from each half of the string. As sag angle decreases the vertical component also decreases and so there must be an overall increase in tension.

Risk Level: Low Hazard:

STUDENT:____________________

177

Tectonics

Aim: To use tectonic theory to make deductions about the composition of the Earth.

Equipment

Samples: Granite
Iron
Olivine
Basalt
(approx 3cm diameter)
Balance, 0.1g sensitivity
Measuring Cylinder, 200ml
Calculator

Procedure

Weigh the granite sample.
Place 100mls of water in the cylinder.
Tilt the cylinder and slide your sample into the water.
The increase in volume is the volume of your sample.
Calculate the density of the granite. D = Mass/ Volume.
Repeat these steps for each sample.
Write a list of the samples in order of increasing density
Tectonic theory requires that continental plates are less dense than ocean plates. These plates in turn float upon the Mantle which floats upon the Earths core.

Which of the samples would you expect to find in; the core, the mantle, ocean plates and continental plates.

Rock	Mass	Volume	Density	Earth Layer

Results: ____________________

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Conclusion: ____________________

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177

Tectonics

Topics: Quakes & Volcanoes Density/Pressure The Earth

Aim: To use tectonic theory to make deductions about the composition of the Earth.

Equipment

Samples: Granite
Iron
Olivine
Basalt
(approx 3cm diameter)
Balance, 0.1g sensitivity
Measuring Cylinder, 200ml
Calculator

Procedure

Weigh the granite sample.
Place 100mls of water in the cylinder.
Tilt the cylinder and slide your sample into the water.
The increase in volume is the volume of your sample.
Calculate the density of the granite. D = Mass/ Volume.
Repeat these steps for each sample.
Write a list of the samples in order of increasing density
Tectonic theory requires that continental plates are less dense than ocean plates. These plates in turn float upon the Mantle which floats upon the Earths core.

Which of the samples would you expect to find in; the core, the mantle, ocean plates and continental plates.

Result: Iron is most dense, followed by Olivine then Basalt and finally Granite.

Conclusion: Iron is a likely component of the Earths core, Olivine a likely component of the Mantle, Basalt a major component of Ocean Plates and Granite a major component of Continental Plates

Risk Level: Low Hazard;

STUDENT:__________________

178 Temp versus Heat

Aim: To observe the differences between heat and temperature, particularly in relation to changes of state.

Equipment

Ice
Bunsen and Tripod
250ml Beaker
Graph Paper
Thermometer
Retort Stand, boss and clamp

Procedure

Set up beaker on tripod.
Use the retort stand to suspend the thermometer in the centre of the beaker but not touching the base.
Add ice to the beaker.
Light Bunsen but do not begin heating.
Record the temperature.
At a signal from the teacher, begin heating and record the temperature every thirty seconds.
Stop when the water has boiled for two minutes.

Time (mins)	Temp	Time	Temp
0		5	
0.5		5.5	
1		6	
1.5		6.5	
2		7	
2.5		7.5	
3		8	
3.5		8.5	
4		9	
4.5		9.5	

Results: ____

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Conclusion: ____

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178

Temp versus Heat

Topics: Matter Energy Changes of State

Aim: To observe the differences between heat and temperature, particularly in relation to changes of state.

Equipment	**Procedure**
Ice	Set up beaker on tripod.
Bunsen and Tripod	Use the retort stand to suspend the thermometer in the centre of the beaker but not touching the base.
250ml Beaker	Add ice to the beaker.
Graph Paper	Light Bunsen but do not begin heating.
Thermometer	Record the temperature.
Retort Stand, boss and clamp	At a signal from the teacher, begin heating and record the temperature every thirty seconds.
	Stop when the water has boiled for two minutes.

Result: Despite continuous heating the temperature rose only slowly at first then increased smoothly to 100 degrees and then would rise no further.

Conclusion: Heat is not the same thing as temperature. Temperature remains relatively constant, despite heating, whenever a substance is changing state.

Risk Level: Low Hazard

STUDENT:____________________

179

The Seasons

Aim: To demonstrate how the tilt of the Earths axis produces seasons.

Equipment

Globe of the Earth
Overhead projector
Extension lead
Trolley
Cardboard Tube, map type

Procedure

Draw a diagram of the Earth and the Sun based on the teacher demonstration which shows why winter is cooler than summer.

Results: ____

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Conclusion: ____

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179

The Seasons

Topics: The Earth The Sky

Aim: To demonstrate how the tilt of the Earths axis produces seasons.

Equipment

Globe of the Earth
Overhead projector
Extension lead
Trolley
Cardboard Tube, map type

Procedure

Set up the overhead projector on the trolley.
Use the extension lead to connect the projector in the centre of the room.
A student stands toward the front of the room holding the the mounted globe in the projector beam with the globe axis tilted toward the black board.
Turn the globe on its axis to demonstrate night and day
Point out that turning west to east puts eastern points in an earlier time zone except when crossing the international date line which changes the name of the day.

Use the cardboard tube to project a clear circular beam of light on Australia.
Note the shape of the lighted area.
The student now moves to the back of the room but keeps the axial tilt toward the blackboard.
Note the new shape of the lighted area when the projector and tube are swung around.

Result: When the globe is toward the front of the room the lighted area over Australia is roughly circular. When the globe is at the back of the room Australia faces downward and the lighted area is an elongated ellipse.

Conclusion: In summer, light from the sun falls on a compact area. As winter approaches, the land is tilted away from the sun, spreading the same heat and light over a larger area and so it is colder. The same effect explains why it is much colder at the poles than at the equator.

Risk Level: Low Hazard

STUDENT:____________________

180 Thermocouples

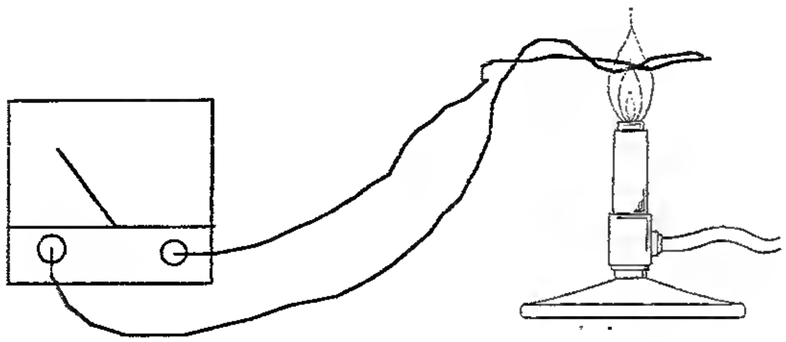
Aim: To produce an electric current by merely heating wires.

Equipment

Nichrome wire, 30cm
Copper wire, 30 cm
Microammeter
Bunsen

Procedure

Twist one end of the nichrome wire around one end of the copper wire.
Connect the remaining wire ends to the microammetre
Measure the current.
Heat the twisted wire ends in the Bunsen flame.
Measure the current.



Results: ____

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Conclusion: ____

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180

Thermocouples

Topics: Electricity Heat

Aim: To produce an electric current by merely heating wires.

Equipment

Nichrome wire, 30cm
Copper wire, 30 cm
Microammeter
Bunsen

Procedure

Twist one end of the nichrome wire around one end of the copper wire.
Connect the remaining wire ends to the microammetre
Measure the current.
Heat the twisted wire ends in the Bunsen flame.
Measure the current.

Result: A small electric current is produced.

Conclusion: A thermocouple is two metals of different conductivity joined in a circuit. If one end of the couple is hotter than the other then an electric current flows. Heating excites electrons. The more conductive metal is good electron donor while the less reactive metal is better at capturing electrons, hence a current will flow when electrons are excited and mobile.

Risk Level: Low Hazard.

STUDENT:____________________

181 Ticker Timer 1

Aim: To measure the acceleration due to gravity using a ticker timer record.

Equipment
Ticker Timer
Power Supply, 12V AC
Connecting leads, 2
Mass
Sticky tape
Carbon Paper
Paper tape

Procedure
Refresh the carbon paper on the ticker timer.
Connect the timer to the power supply, setting at 6V AC.
Arrange the timer , on its side, at the edge of a bench.
Insert one end of a 0.5m length of paper taper through the timer guides.
Use sticky tape to attach a 50g mass to the paper.
Hold the paper vertically by its free end.
Turn on the power and immediately release the paper.
Measure the distance to the eleventh dot.
The timer makes a dot every 0.02 seconds.

$s = ut + 1/2\ at^2$, where s = the distance from the origin dot to the eleventh dot, t = number of dots excluding the origin, mutiplied by 0.02 (ie. 0.2 seconds), u = 0,
a = acceleration due to gravity
Hint : The first dot is often obscured in the origin blur.

Results: ____

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Conclusion: ____

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181

Ticker Timer 1

Topics: Forces Linear Motion

Aim: To measure the acceleration due to gravity using a ticker timer record.

Equipment

Ticker Timer
Power Supply, 12V AC
Connecting leads, 2
Mass
Sticky tape
Carbon Paper
Paper tape

Procedure

Refresh the carbon paper on the ticker timer.
Connect the timer to the power supply, setting at 6V AC.
Arrange the timer , on its side, at the edge of a bench.
Insert one end of a 0.5m length of paper taper through the timer guides.
Use sticky tape to attach a 50g mass to the paper.
Hold the paper vertically by its free end.
Turn on the power and immediately release the paper.
Measure the distance to the eleventh dot.
The timer makes a dot every 0.02 seconds.

$s = ut + 1/2\ at^2$, where s = the distance from the origin dot to the eleventh dot, t = number of dots excluding the origin, mutiplied by 0.02 (ie. 0.2 seconds), u = 0,
a = acceleration due to gravity
Hint : The first dot is often obscured in the origin blur.

Result: The dots generally became further apart although there was some variation.

Conclusion: The ticker timer produces a result of about 9m/sec/sec for acceleration due to gravity. There is some variation in timer accuracy and of course there is the friction of the paper to slow the fall. This experiment is rapidly repeatable and useful to ensure each student has a ticker timer record to work on.

Risk Level: Low Hazard

STUDENT:________________

182 Ticker Timer Records

Aim: To determine the force delivered by a collision trolley spring using ticker timer records.

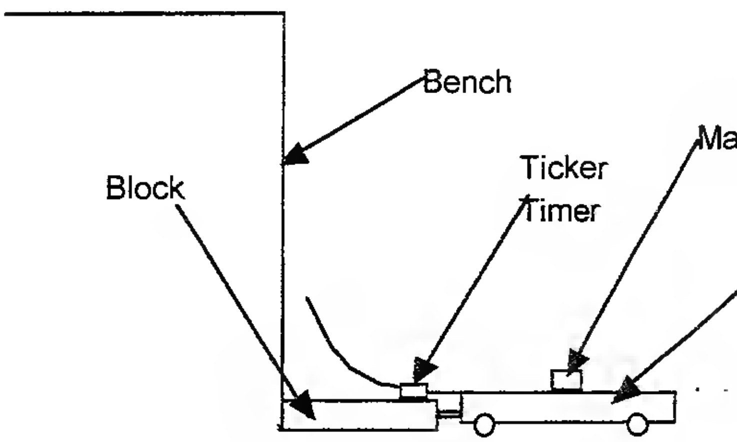
Equipment

Ticker Timer
Paper Tape
Carbon Paper
Collision Trolley
Masses, 250g, 500g
Power Supply 6V,AC
Retort Stand, Boss & Clamp
Wooden Block
Sticky Tape

Procedure

Set up a ticker timer on the floor (vinyl) using a retort stand and clamp, then connect to the power supply 6 Volt,AC.
Place carbon paper on the spike beneath the ticker hammer and thread 50cm of paper tape.
Prime the collision trolley spring against a fixed block.
Stick the end of the paper tape to the trolley.
Start the ticker timer and trigger the trolley spring .
Recover the tape.
Repeat with a 250g mass on the trolley and then 500g.
Weigh the collision trolley.

Measure the distance over the first six dots.
Each ticker timer dot represents 0.02 seconds
ie. $t = 0.1$ sec
Calculate the acceleration from $s = ut + 1/2\ at^2$
Calculate the force in each case from $F=ma$, where m is the total of the trolley weight plus masses.



Results: ________________________________

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Conclusion: ________________________________

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182

Ticker Timer Records

Topics: Forces Linear Motion

Aim: To determine the force delivered by a collision trolley spring using ticker timer records.

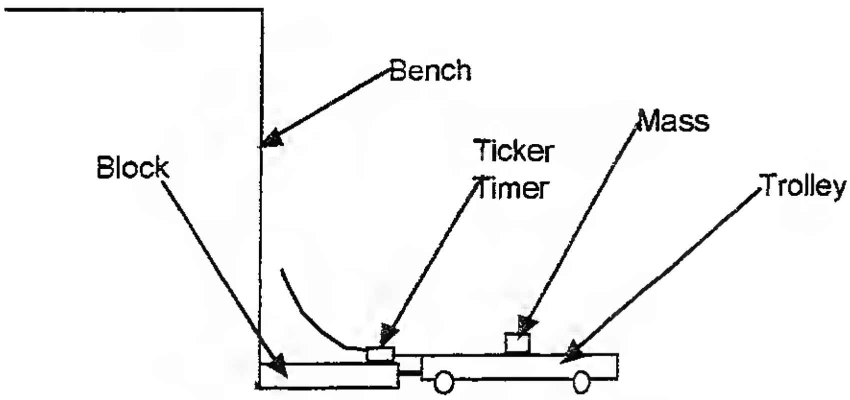
Equipment

Ticker Timer
Paper Tape
Carbon Paper
Collision Trolley
Masses, 250g, 500g
Power Supply 6V,AC
Retort Stand, Boss & Clamp
Wooden Block
Sticky Tape

Procedure

Set up a ticker timer on the floor (vinyl) using a retort stand and clamp, then connect to the power supply 6 Volt,AC.
Place carbon paper on the spike beneath the ticker hammer and thread 50cm of paper tape.
Prime the collision trolley spring against a fixed block.
Stick the end of the paper tape to the trolley.
Start the ticker timer and trigger the trolley spring .
Recover the tape.
Repeat with a 250g mass on the trolley and then 500g.
Weigh the collision trolley.

Measure the distance over the first six dots.
Each ticker timer dot represents 0.02 seconds
ie. $t = 0.1$ sec
Calculate the acceleration from $s = ut + 1/2\ at^2$
Calculate the force in each case from $F=ma$, where m is the total of the trolley weight plus masses.



Result: Using the same force, the trolley acceleration is less as masses are added.

Conclusion: The force of the trolley spring can be calculated with reasonable accuracy however some of the sources of errors are: Friction, variation in the ticker timer and blurring of the start point on the tape record.

Risk Level: Low Hazard

STUDENT:________________

183

Touch Sense

Aim: To investigate touch sense

Equipment

Shoe box containing:
1 rock, granite
1 button
1 leaf
1 feather, down
1 ice cube
1 pin cushion, small
Dissecting probes,blunt, 2

Procedure

1.Close your eyes, reach into the box and pick up an object. Thoroughly describe the object before guessing what it is. The adjectives used are recorded as touch senses.

2. In groups.

One student closes their eyes. Another student touches one or two probes on the back of the subjects hand. The probes must touch simultaneously. The subject calls out 'one' or 'two". A third student records a tick for correct or a cross for incorrect.

The experimenter should try various distances between the probes 2mm to 20mm and randomly use only one probe. Repeat the experiment for the tip of a finger.

Results: ____

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Conclusion: ____

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183

Touch Sense

Topics: Coordination

Aim: To investigate touch sense

Equipment

Shoe box containing:
1 rock, granite
1 button
1 leaf
1 feather, down
1 ice cube
1 pin cushion, small
Dissecting probes,blunt, 2

Procedure

1.Students are to close their eyes, reach into the box and pick up an object. They must thoroughly describe the object before guessing what it is. The adjectives used are recorded as touch senses.

2. In groups.
One student closes their eyes. Another student touches one or two probes on the back of the subjects hand. The probes must touch simultaneously. The subject calls out 'one' or 'two". A third student records a tick for correct or a cross for incorrect.

The experimenter should try various distances between the probes 2mm to 20mm and randomly use only one probe. Repeat the experiment for the tip of a finger.

Result: Touch senses reported include: soft/hard, rough/smooth, hot/cold, wet/dry slippery, prickly. The student reporting probe touches is often wrong especially when the probes touch less than 10 mm apart.

Conclusion: Touch sense is very complex including many specialised nerves which are not evenly spread about the body.

Risk Level: Low Hazard

STUDENT:____________________

184

Vacuum Boiling

Aim: To demonstrate that liquids boil at lower temperatures as pressure decreases.

Equipment

Round Bottom Flask
Rubber stopper
Retort stand and clamp
Bunsen
cloth

Procedure

Half fill the flask with water.
Set up on the retort stand.
Heat with the Bunsen until the water is boiling vigorously.
Insert the rubber stopper as the Bunsen is turned off.
Dampen the cloth with cool water.
Wipe the damp cloth over the upper portion of the flask.

Results: ____

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Conclusion: ______________________________________

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184

Vacuum Boiling

Topics: Density/Pressure   Water   How atoms Join

Aim: To demonstrate that liquids boil at lower temperatures as pressure decreases.

Equipment	**Procedure**
Round Bottom Flask	Half fill the flask with water.
Rubber stopper	Set up on the retort stand.
Retort stand and clamp	Heat with the Bunsen until the water is boiling vigorously.
Bunsen	Insert the rubber stopper as the Bunsen is tumed off.
cloth	Dampen the cloth with cool water.
	Wipe the damp cloth over the upper portion of the flask.

Result: Cooling the upper portion of the flask causes the water to begin boiling again.

Conclusion: Steam from the boiling water expels air from the flask. Cooling the upper portion of the flask causes invisible vapour to condense leaving a near vacuum above the water. The much reduced pressure allows the water to boil though its temperature is now less than one hundred degrees.

Risk Level: Moderate Hazard: Only good quality flasks should be used as there is a slight risk of implosion.

STUDENT:____________________

185

Van de Graaf 1

Aim: To demonstrate some of the effects of electrostatic force.

Equipment

Van de Graaf Generator
Hank of long hair
party balloons
string

Procedure

1/ What happens when the wand approaches the dome.
2/ Attach a hank of hair to the dome.
3/ Inflate two party balloons and join them with 1 metre of string. Hang the balloons by the string so they contact the dome.
Draw the experiments in the space below.

Results: ____

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Conclusion: ____

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185

Van de Graaf 1

Topics: Atoms & Molecules   Electrostatics

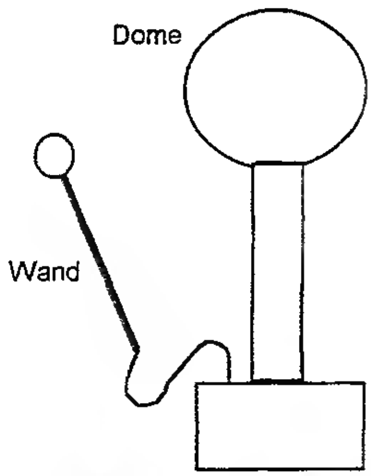
Aim: To demonstrate some of the effects of electrostatic force.

Equipment

Van de Graaf Generator
Hank of long hair
party balloons
string

Procedure

On a dry day (low humidity) set up the Van De Graaf Generator.
1/ Demonstrate sparks from the wand to the dome.
Demonstrate attraction before each spark jumps.
2/ Attach a hank of hair to the dome.
Ask a student volunteer with fine hair to touch the globe for one minute.
3/ Inflate two party balloons and join them with 1 metre of string. Hang the balloons by the string so they contact the dome.



Result: The balloons and hairs repelled each other, spreading apart.

Conclusion: Objects in contact with the dome acquire a similar charge. Like charges repel.

Risk Level: Mild hazard: Students must keep their face away from the dome as sparks to the eyes can cause damage.

STUDENT:________________

186

Van De Graaf 2

Aim: To observe some of the properties of electrostatic force and the the effects of electron flow.

Equipment

Van de Graaf generator
Fluorescent tube,20W
Alfoil strips

Procedure

1/ Connect a fluorescent tube between the wand and dome.
2/ Stick some alfoil strips to the crest of the dome.
Observe how the strips respond to the proximity of your hand.
Draw the experiments in the space below.

Results: ______________________________

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Conclusion: ______________________________

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186

Van De Graaf 2

Topics: Atoms electricity

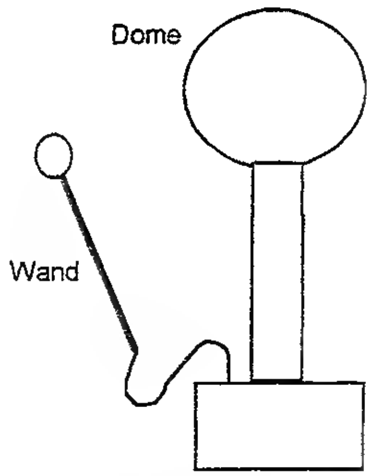
Aim: To observe some of the properties of electrostatic force and the the effects of electron flow.

Equipment

Van de Graaf generator
Fluorescent tube,20W
Alfoil strips

Procedure

Allow the generator to charge.
1/ Demonstrate sparking from the wand to the dome.
2/ Connect a fluorescent tube between the wand and dome.
3/ Turn off the generator and stick some alfoil strips to the crest of the dome.
Turn on the generator
Observe the behaviour of the strips
Observe how the strips behave in response to the proximity of the wand.
Observe how the strips respond to the proximity of your hand.



Result: The fluorescent tube flickered with light. The Alfoil strips stood up and spread out but were attracted to the wand or a hand.

Conclusion: A large voltage difference develops between the dome and the wand, sufficient to excite the Neon gas in the fluorescent tube. The alfoil strips become flooded with the same charge as the dome and so are repelled by the dome and each other. The wand (connected to earth) and the human hand become oppositely charged by induction thereby attracting the alfoil.

Risk Level: Moderate Hazard: Students should not allow their face close to the Van de Graaf. Sparking to the eyes can cause damage.

STUDENT:________________

187

Vector Tension

Aim: To determine the acceleration due to gravity using a vector device.

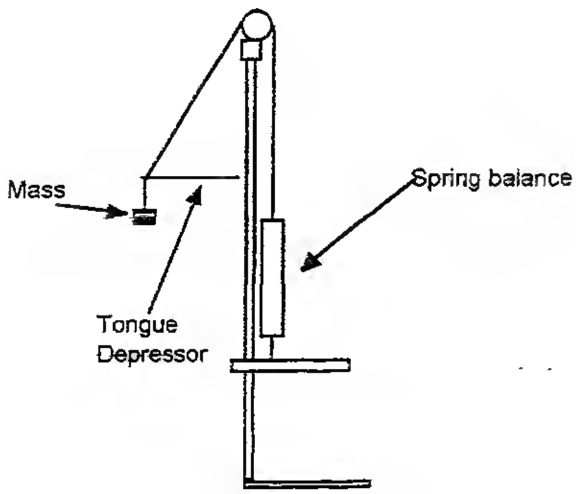
Equipment

Single pulley/clamp
String, 0.5m
Spring Balance, 5N
Retort stand and clamp
Wooden tongue depressor
small triangle file
Mass carrier
mass, 50g
Protractor

Procedure

Mount the pulley at the top of the retort stand.
Use the file to cut V shapes in each end of the tongue depressor.
Mount the clamp low on the retort.
Tie the string between the mass carrier and spring balance.
Hook the spring balance on the clamp passing the string over the pulley then let the mass carrier hang with the tongue depressor as a horizontal prop between the retort and the carrier.
Lifting the mass carrier slightly, note the spring balance

reading as the string sags.
Add the 50g mass to the carrier.
Record the spring balance reading.
Record the angle between the retort and the string.
By adjusting the clamp position repeat the experiment for two different angles.
Calculate "g" from the known mass, the force reading on the spring balance and vector analysis of the string tension.



Results: ____

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Conclusion: ____

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187

Vector Tension

Topics: Forces

Aim: To determine the acceleration due to gravity using a vector device.

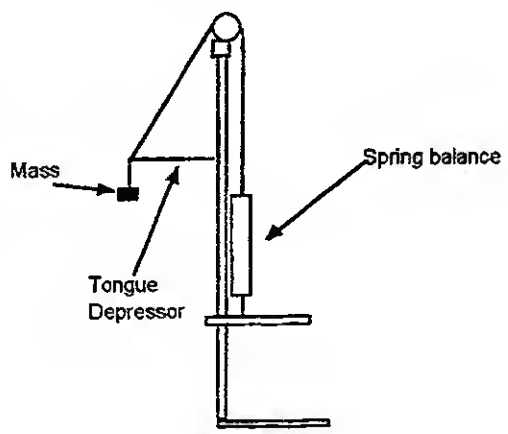
Equipment

Single pulley/clamp
String, 0.5m
Spring Balance, 5N
Retort stand and clamp
Wooden tongue depressor
small triangle file
Mass carrier
mass, 50g
Protractor

Procedure

Mount the pulley at the top of the retort stand.
Use the file to cut V shapes in each end of the tongue depressor.
Mount the clamp low on the retort.
Tie the string between the mass carrier and spring balance.
Hook the spring balance on the clamp passing the string over the pulley then let the mass carrier hang with the tongue depressor as a horizontal prop between the retort and the carrier.
Lifting the mass carrier slightly, note the spring balance

reading as the string sags.
Add the 50g mass to the carrier.
Record the spring balance reading.
Record the angle between the retort and the string.
By adjusting the clamp position repeat the experiment for two different angles.
Calculate "g" from the known mass, the force reading on the spring balance and vector analysis of the string tension.



Result: The results are surprisingly accurate.

Conclusion: The horizontal prop increases string tension which is the sum of two vectors. The vertical vector is "mg" and the horizontal vector is force exerted by the prop.

Risk Level: Low Hazard

STUDENT: ____________________

Video Expt 1

Aim: To observe acceleration due to gravity using freeze frame video records.

Equipment

Video Camera
Butchers Paper, 4m length
Dark coloured ball
Metre rule
Marking pen
Good natural lighting
Blue Tack

Procedure

On the butchers paper, make pronounced lines every 0.25 metre marked in figures 15cm tall.
Use blue tack to fix the paper vertically to the wall (smallest numbers highest).
Set the video camera to 1/1000 shutter speed.
Position the camera about 4m from the paper.
A student holds the ball at the origin line on the paper.
With a loudly spoken count down the student drops the ball.

Review the tape using freeze frame play back.
The count down will help cue the tape.
Each frame is 1/24 of a second.
Record the distance travelled in each frame.

Frame	Distance	Frame	Distance
1		11	
2		12	
3		13	
4		14	
5		15	
6		16	
7		17	
8		18	
9		19	
10		20	

Results: ____________________

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Conclusion: ____________________

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188

Video Expt 1

Topics: Linear Motion Forces

Aim: To observe acceleration due to gravity using freeze frame video records.

Equipment

Video Camera
Butchers Paper, 4m length
Dark coloured ball
Metre rule
Marking pen
Good natural lighting
Blue Tack

Procedure

On the butchers paper make pronounced lines every 0.25 metre marked in figures 15cm tall.
Use blue tack to fix the paper vertically to the wall (smallest numbers highest).
Set the video camera to 1/1000 shutter speed.
Position the camera about 4m from the paper.
A student holds the ball at the origin line on the paper.
With a loudly spoken count down the student drops the ball.

Review the tape using freeze frame play back.
The count down will help cue the tape.
Each frame is 1/24 of a second.
Record the distance travelled in each frame.

Result: As the ball falls the distance travelled increases for each video frame

Conclusion: In this case $s = 10\ t^2$.

Risk Level: Low Hazard

STUDENT:____________________

189

Video Expt 2

Aim: To observe collisions in slow motion using video freeze frame playback.

Equipment

Video camera and tripod
Party Balloons , round and dark colours.
Student desk

Procedure

Set up a student desk outside in an area below a balcony or walkway.
Set up the video camera about 2 metre from the table and level with its surface.
Set the camera to 1/1000 shutter speed.
Half fill several balloons with water.
With a loudly spoken countdown, a student on the balcony drops each balloon onto the table.
Review video of the collisions, frame by frame.

Results: ____

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Conclusion: ____

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189

Video Expt 2

Topics: Momentum Impulse Forces

Aim: To observe collisions in slow motion using video freeze frame playback.

Equipment

Video camera and tripod
Party Balloons , round and dark colours.
Student desk

Procedure

Set up a student desk outside in an area below a balcony or walkway.
Set up the video camera about 2 metre from the table and level with its surface.
Set the camera to 1/1000 shutter speed.
Half fill several balloons with water.
With a loudly spoken countdown, a student on the balcony drops each balloon onto the table.
Review video of the collisions, frame by frame.

Result: The balloons are observed to flatten on the table and then rebound as a dumbbell shape which oscillates between vertical and lateral stretching.

Conclusion: The collision causes lateral spreading of the balloon however the elastic recoil meets in the centre and is forced to spread vertically, the recoil from this position is in turn forced to spread laterally. The countdown helps cue the video to each collision.

Risk Level: Low Hazard: Great Fun, especially when a balloon bursts.

STUDENT:____________________

190

Volcano

Aim: To demonstrate the flow pattern of volcanic ash and to simulate a mild eruption.

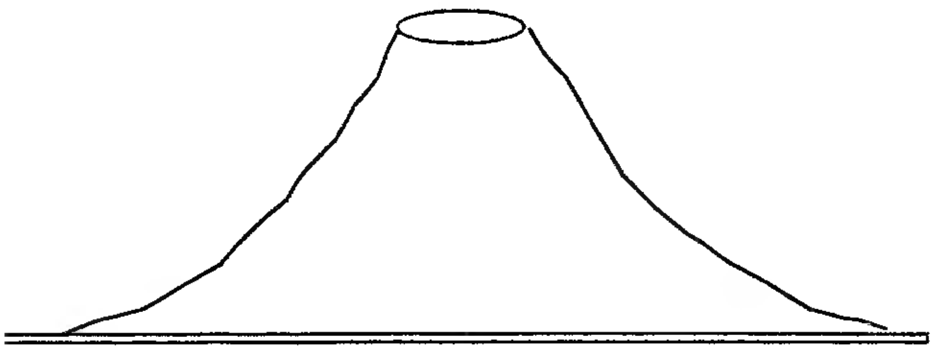
Equipment

50cm square of plywood
2kg Plaster of Paris
Nails or screws
100mm, squat , flower pot
Ammonium Dichromate
Magnesium Ribbon
Bucket
Water colour paint, brown
Newspaper
Cigarette lighter
Tongs

Procedure

Invert the flower pot in the centre of the ply wood.
Drive nails or screws into the ply around the pot to provide anchors for the plaster.
Prepare the plaster in a bucket .
Pour the plaster over the pot and shape into a steep sided volcanic cone with a central crater about 5cm wide and 3cm deep. Allow the plaster to dry for 24 hours before painting brown.

Outside or in a fume cupboard: Spread Newspaper 1m by 1m.
Fill the cone with ammonium dichromate.
Light a 5cm length of magnesium ribbon and plunge the burning end into the dichromate.
Draw the result on the diagram below.
Would this type of erruption tend to build steep cones or flat cones? ____________________
What does this imply about sheild volcanos?



Results: ____

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Conclusion: ____

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190

Volcano

Topics: Volcanoes Geology

Aim: To demonstrate the flow pattern of volcanic ash and to simulate a mild eruption.

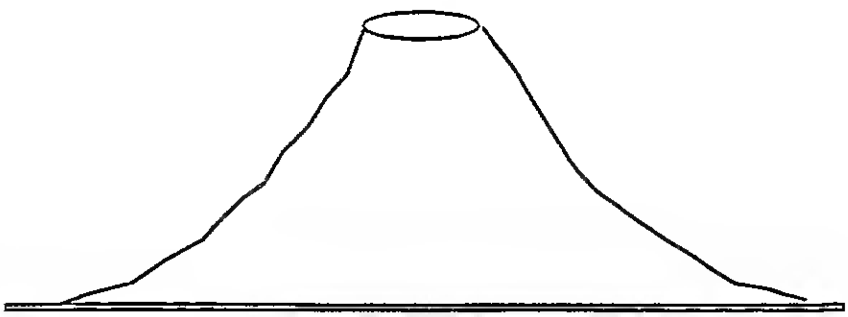
Equipment

50cm square of plywood
2kg Plaster of Paris
Nails or screws
100mm, squat , flower pot
Ammonium Dichromate
Magnesium Ribbon
Bucket
Water colour paint, brown
Newspaper
Cigarette lighter
Tongs

Procedure

Invert the flower pot in the centre of the ply wood.
Drive nails or screws into the ply around the pot to provide anchors for the plaster.
Prepare the plaster in a bucket .
Pour the plaster over the pot and shape into a steep sided volcanic cone with a central crater about 5cm wide and 3cm deep. Allow the plaster to dry for 24 hours before painting brown.

Outside or in a fume cupboard: Spread Newspaper 1m by 1m.
Fill the cone with ammonium dichromate.
Light a 5cm length of magnesium ribbon and plunge the burning end into the dichromate.



Result: Sparks and gas escape from the volcano while ash fills the crater and then spills down the flanks of the cone.

Conclusion: Volcanic cones build by repeated eruptions which flow and solidify in layers. Fast lava flows build broad, Shield Volcanoes, while more viscous lava flows and ash, produce steep cones.

Risk Level: HAZARDOUS: Teacher Demonstration only. this experiment should be done outside or in a fume hood due to toxic fumes. Since chemical spill is expected, the teacher should have gloves and prepare for the clean up eg spread newspapers to collect and carry the spent chemical to a solid waste container in the laboratory.

STUDENT:________________

191 Water & Electrons

Aim: To compare the flow of electrons with the flow of water.

Equipment

stop watch
Plastic Measuring Cylinder, 500ml prepared:
Plaster of Paris
Poly pipe, 12mm, 15cm, 4
Fittings: T-piece, elbow, joins(2), stop cock

Drill a hole in at the base of the cylinder and fit an elbow with tubing to reach 100ml. Carefully fill around the tubing with plaster of paris

Procedure

1/With the stop cock closed fill the cylinder to 300mls
Release the stop cock over the sink and time how long it takes for the 200mls of water to drain.
Calculate the flow rate.
2/ Fill the cylinder to 500mls, release the stop cock and calculate the new flow rate for 400mls.
3/ Connect a T piece. refill the cylinder to 300ml.
Measure the time for the 200ml to drain.
Calculate the flow rate.
4/ Remove the T piece and add a connector with its outlet narrowed (eg jam a pen tube inside).
Measure and calculate the new flow rate for 200mls.

Experiment	Volume	Time	Flow Rate

Results: ____

____

____

Conclusion: ____

____

____

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Water & Electrons

Topics: Electricity

Aim: To compare the flow of electrons with the flow of water.

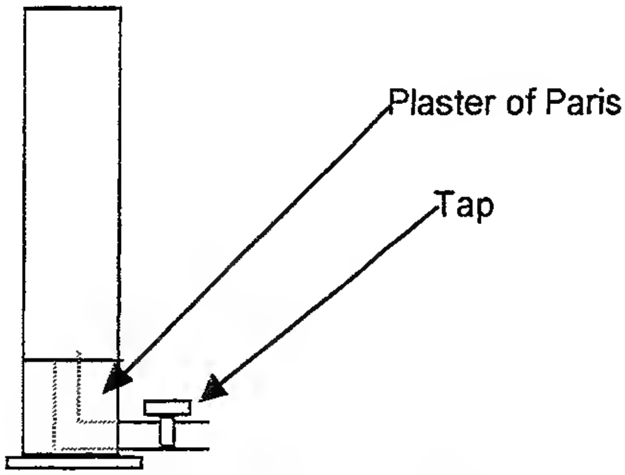
Equipment

stop watch
Plastic Measuring Cylinder, 500ml prepared:
Plaster of Paris
Poly pipe, 12mm, 15cm, 4
Fittings: T-piece, elbow, joins(2), stop cock

Drill a hole in at the base of the cylinder and fit an elbow with tubing to reach 100ml. Carefully fill around the tubing with plaster of paris

Procedure

With the stop cock closed fill the cylinder to 300mls
Release the stop cock over the sink and time how long it takes for the 200mls of water to drain.
Calculate the flow rate.
Fill the cylinder to 500mls, release the stop cock and calculate the new flow rate for 400mls.
Connect a T piece. refill the cylinder to 300ml.
Measure the time for the 200ml to drain.
Calculate the flow rate.
Remove the T piece and add a connector with its outlet narrowed (eg jam a pen tube inside)
Measure and calculate the new flow rate for 200mls.



Result: The flow rate increases with higher water level in the cylinder. Flow rate increases with the T-piece. Flow rate decreases with the narrow tube.

Conclusion: Flow rate is analogous to Amperage in electron flow. Water level or "Head" height is analogous to Voltage. The T- piece simulates a parallel circuit while the narrow tube simulates a resistor. Resistors reduce flow rate (amperage). Parallel circuits increase flow rate (amperage). Increased head (voltage) increases flow rate (amperage).

Risk Level: Low Hazard

STUDENT:__________________

192 Water of Crystallisation

Aim: To determine the ratio of water molecules to copper sulfate in hydrated crystals of that compound.

Equipment

Balance, 0.1g accuracy
Crucible and lid
Bunsen, tripod
Pipe clay triangle
tongs
Copper Sulfate

Procedure

Heat a crucible mounted on a pipe clay triangle and tripod for five minutes.
Allow to cool for 2 minutes
Weigh the crucible, add 2 - 3g of copper sulfate and immediately reweigh.
Heat the crucible strongly for 20 mins with the lid slightly ajar. The blue crystal will become white.
Reweigh the crucible.
Calculate the mass of dried copper sulfate and the mass of water driven from the original crystals.

Moles of $CuSO_4$ = Dry mass / 159.6

Moles of Water = Mass loss / 18.0

Results: ____

____

____

Conclusion: ______________________________________

____

____

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192

Water of Crystallisation

Topics: Atoms & Molecules Making Compounds Mole Concept

Aim: To determine the ratio of water molecules to copper sulfate in hydrated crystals of that compound.

Equipment

Balance, 0.1g accuracy
Crucible and lid
Bunsen, tripod
Pipe clay triangle
tongs
Copper Sulfate

Procedure

Heat a crucible mounted on a pipe clay triangle and tripod for five minutes.
Allow to cool for 2 minutes
Weigh the crucible, add 2 - 3g of copper sulfate and immediately reweigh.
Heat the crucible strongly for 20 mins with the lid slightly ajar. The blue crystal will become white.
Reweigh the crucible.
Calculate the mass of dried copper sulfate and the mass of water driven from the original crystals.

Moles of $CuSO_4$ = Dry mass / 159.6

Moles of Water = Mass loss / 18.0

Result:

Conclusion: Copper sulfate is a pentahydrate

Risk Level: Moderate Hazard: Copper sulfate is harmful if ingested and can burn eye membranes. Beware of exploding crystals during heating. Wear safety glasses.

STUDENT:____________________

193 Water of Crystallisation

Aim: To determine the ratio of water molecules to barium chloride in hydrated crystals of that compound.

Equipment

Balance, 0.1g accuracy
Crucible and lid
Bunsen, tripod
Pipe clay triangle
tongs
Barium Chloride

Procedure

Heat a crucible mounted on a pipe clay triangle and tripod for five minutes.
Allow to cool for 2 minutes.
Weigh the crucible, add 2 - 3g of Barium chloride and immediately reweigh.
Heat the crucible strongly for 20 mins with the lid slightly ajar.
Reweigh the crucible.
Calculate the mass of dried barium chloride and the mass of water driven from the original crystals.

Moles of $BaCl_2$ = Dry mass / 208.2

Moles of Water = Mass loss / 18.0

Results: ____

____

____

Conclusion: ____

____

____

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193

Water of Crystallisation

Topics: Atoms & Molecules Making Compounds Mole Concept

Aim: To determine the ratio of water molecules to barium chloride in hydrated crystals of that compound.

Equipment

Balance, 0.1g accuracy
Crucible and lid
Bunsen, tripod
Pipe clay triangle
tongs
Barium Chloride

Procedure

Heat a crucible mounted on a pipe clay triangle and tripod for five minutes.
Allow to cool for 2 minutes.
Weigh the crucible, add 2 - 3g of Barium chloride and immediately reweigh.
Heat the crucible strongly for 20 mins with the lid slightly ajar.
Reweigh the crucible.
Calculate the mass of dried barium chloride and the mass of water driven from the original crystals.

Moles of $BaCl_2$ = Dry mass / 208.2

Moles of Water = Mass loss / 18.0

Result:

Conclusion: Barium chloride is a dihydrate

Risk Level: HAZARDOUS: Barium chloride is toxic, harmful if inhaled and harmful by skin contact.

STUDENT:____________________

194

Water Rocket

Aim: To observe Newtons third law of motion: for every action there is an equal and opposite reaction

Equipment

Bicycle pump
1.25L Soft Drink Bottle (PET) Plastic
Tyre Valve, Truck tyre (Tubeless, squat)

Procedure

Half fill the plastic bottle with water.
Force the valve into the bottle mouth.
Connect the pump and invert the bottle.
Pump in air (about 40 strokes)
Draw the apparatus in the space below.

Results: ____

____

____

Conclusion: ____

____

____

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194

Water Rocket

Topics: Density/Pressure Forces

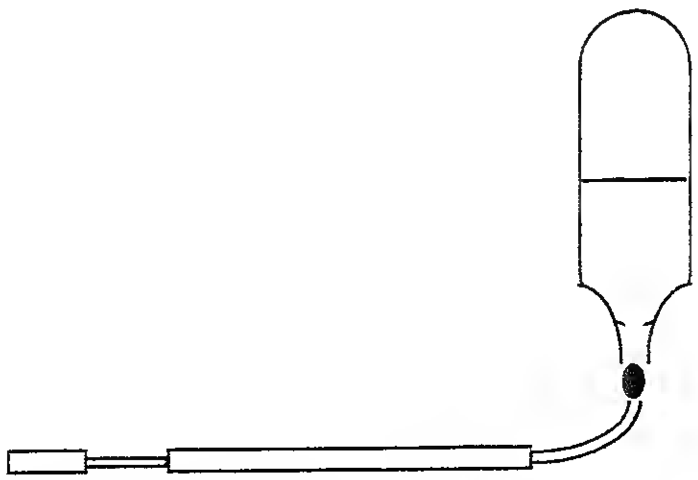
Aim: To observe Newtons third law of motion: for every action there is an equal and opposite reaction

Equipment

Bicycle pump
1.25L Soft Drink Bottle (PET) Plastic
Tyre Valve, Truck tyre (Tubeless, squat)

Procedure

Half fill the plastic bottle with water.
Force the valve into the bottle mouth.
Connect the pump and invert the bottle.
Pump in air (about 40 strokes)
Notes: This is great fun, since the kids get wet and blast off is an unpredictable surprise. If you have a video camera it is great to review a blast off frame by frame.



Result: Air pressure eventually forces the valve free and blasts out the water. The bottle rockets upward to about 20m.

Conclusion: As the water is forced out and down, the bottle is forced upward due to the equal and opposite pressure.

Risk Level: Low Hazard

STUDENT:__________________

195

Wave Tank

Aim: To observe various properties of waves.

Equipment

Wave Tank (shallow transparent dish)
Wave Maker (or a ruler)
Power Supply, 0 -12v
Overhead projector
Small glass sheets
Blocks of various sizes

Procedure

Place the wave tank on the overhead projector.
Fill the tank with water to a depth of about 1cm.
Focus ripples in the water on the projector screen.
Use a wave maker device (or a ruler) to make wave fronts.
A submerged glass sheet will demonstrate refraction.
A large block will demonstrate reflection.
A small block will demonstrate diffraction.
Two blocks close together demonstrate slit diffraction.
Interference is best demonstrated with a twin point source paddle.

Draw the wave patterns produced in each case.

Results: ____

____

____

Conclusion: ____

____

____

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Wave Tank

Topics: Waves | Wave Props Light | Light

Aim: To observe various properties of waves.

Equipment	Procedure
Wave Tank (shallow transparent dish)	Place the wave tank on the overhead projector.
Wave Maker (or a ruler)	Fill the tank with water to a depth of about 1cm.
Power Supply, 0 -12v	Focus ripples in the water on the projector screen.
Overhead projector	Use a wave maker device (or a ruler) to make wave fronts.
Small glass sheets	A submerged glass sheet will demonstrate refraction.
Blocks of various sizes	A large block will demonstrate reflection.
	A small block will demonstrate diffraction.
	Two blocks close together demonstrate slit diffraction.
	Interference is best demonstrated with a twin point source paddle.

Result:

Conclusion:

Risk Level: Low Hazard

STUDENT:________________

Waves In Strings

Aim: To demonstrate standing wave forms where amplitude and wavelength can be measured. To calculate the speed of a wave in a string.

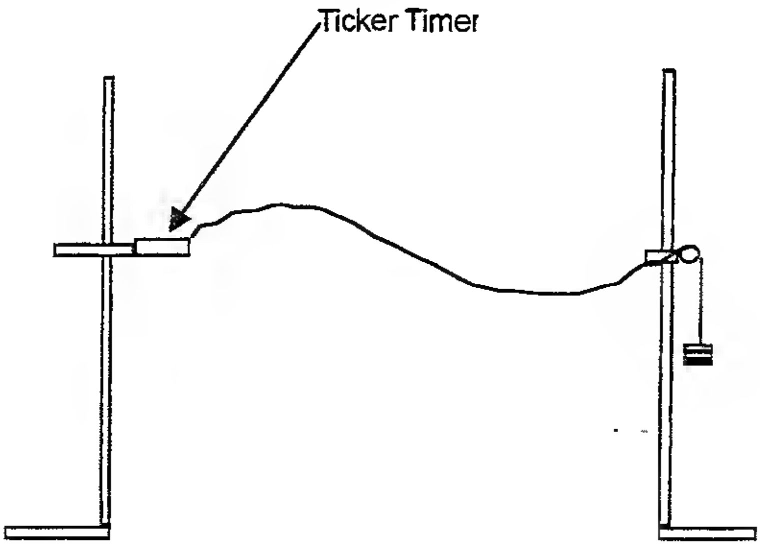
Equipment

Two retort stands, clamps
Ticker timer
Power Supply, 8V, AC
Connecting leads
Mass Carrier
Light string, 2m
Metre rule
Masses, 25g

Procedure

Fix the ticker timer in a clamp on one retort stand.
Tie one end of the string to the ticker arm.
Drape the string over the clamp on the second retort and tie onto the mass carrier.
Connect the power supply.
Adjust the distance between the retort stands until a stable standing wave forms in the string.
Measure the amplitude of the wave. _______
Measure the wavelength. ________

Since the ticker timer frequency is known to be 50 Hertz, calculate the wave velocity by measuring the wavelength.
Velocity = Frequency X Wavelength
= _______ X __________ = __________
Covert this figure to Km/hour._______
Compare this figure to the speed of sound in air (1188km/hr).
Extension: Demonstrate that wave velocity increases as string tension increases. ie the wavelength increases as masses are added to the carrier.



Results: ____

____

____

Conclusion: ____

____

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Waves In Strings

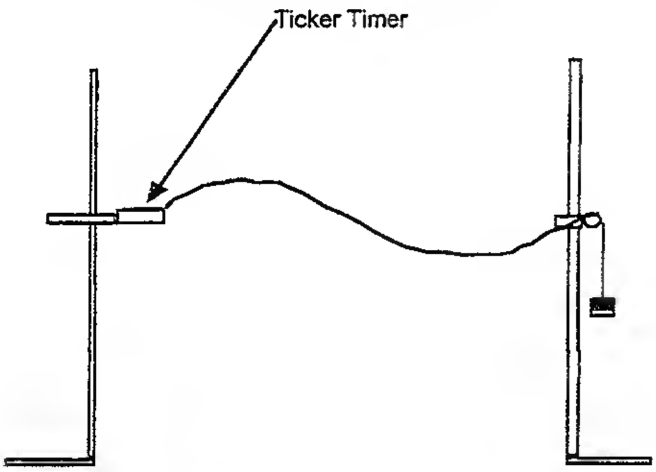
Topics: Waves

Aim: To demonstrate standing wave forms where amplitude and wavelength can be measured. To calculate the speed of a wave in a string.

Equipment
Two retort stands, clamps
Ticker timer
Power Supply, 8V, AC
Connecting leads
Mass Carrier
Light string, 2m
Metre rule
Masses, 25g

Procedure
Fix the ticker timer in a clamp on one retort stand.
Tie one end of the string to the ticker arm.
Drape the string over the clamp on the second retort and tie onto the mass carrier.
Connect the power supply.
Adjust the distance between the retort stands until a stable standing wave forms in the string.

Since the ticker timer frequency is known to be 50 Hertz, calculate the wave velocity by measuring the wavelength.
Velocity = Frequency X Wavelength
Extension: Demonstrate that wave velocity increases as string tension increases. ie the wavelength increases as masses are added to the carrier (some adjustment of the retort stands may be needed).



Result: Clear standing waves form in the string allowing the measurement of amplitude and wavelength.

Conclusion: Waves in strings travel faster than the speed of sound in air. Since the frequency of the vibration is fixed, if wave velocity increases with string tension then wavelength must increase (the opposite occurs in guitar strings).

Risk Level: Low Hazard

STUDENT:____________________

197 Waves In Strings 2

Aim: To demonstrate that velocity changes as a wave moves from one medium to another ie. refraction.

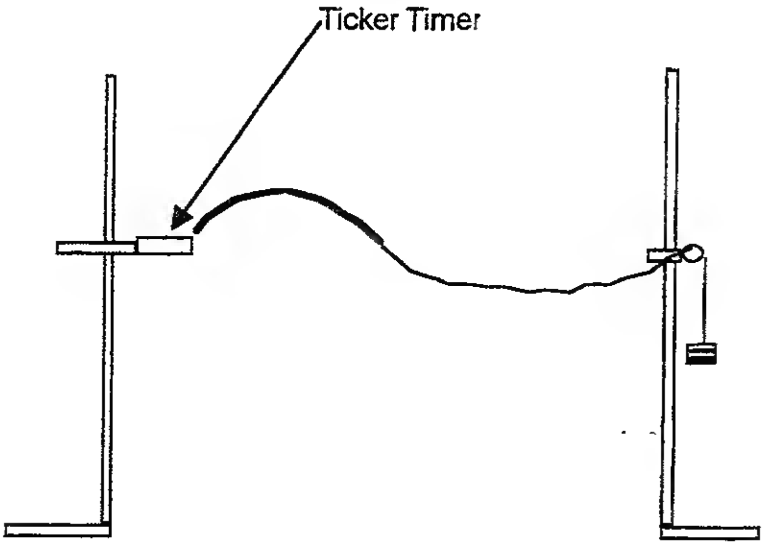
Equipment

Two retort stands, clamps
Ticker timer
Power Supply, 8V, AC
Connecting leads
Mass Carrier
Light string, 1m
Pulley string , 1m
Metre rule
Masses, 25g

Procedure

Fix the ticker timer in a clamp on one retort stand.
Tie one end of light string to the ticker arm and other end to pulley string which is then draped over the clamp on the opposite retort stand.
Tie on the mass carrier and connect the power supply to the ticker timer.
Adjust the distance between the retort stands until a stable standing wave forms in the string.

Since the ticker timer frequency is known to be 50 Hertz, calculate the wave velocity by measuring the wavelength.
Velocity = Frequency X Wavelength



Results: ____

____

____

Conclusion: ____

____

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Waves In Strings 2

Topics: Waves Wave Props Light

Aim: To demonstrate that velocity changes as a wave moves from one medium to another ie. refraction.

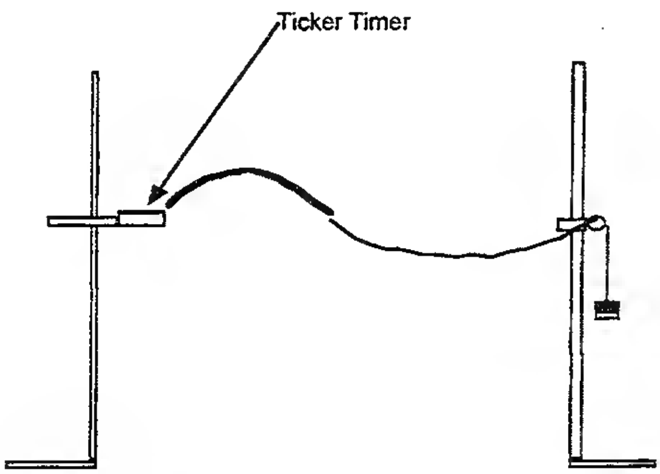
Equipment

Two retort stands, clamps
Ticker timer
Power Supply, 8V, AC
Connecting leads
Mass Carrier
Light string, 1m
Pulley string , 1m
Metre rule
Masses, 25g

Procedure

Fix the ticker timer in a clamp on one retort stand.
Tie one end of light string to the ticker arm and other end to pulley string which is then draped over the clamp on the opposite retort stand.
Tie on the mass carrier and connect the power supply to the ticker timer.
Adjust the distance between the retort stands until a stable standing wave forms in the string.

Since the ticker timer frequency is known to be 50 Hertz, calculate the wave velocity by measuring the wavelength.
Velocity = Frequency X Wavelength



Result: The wavelength is different in the two strings.

Conclusion: Since the frequency of the vibration is fixed if the wavelength is changing between the two strings then so must velocity. From this it is possible to calculate the refractive index of the boundary.

Risk Level: Low Hazard

STUDENT:____________________

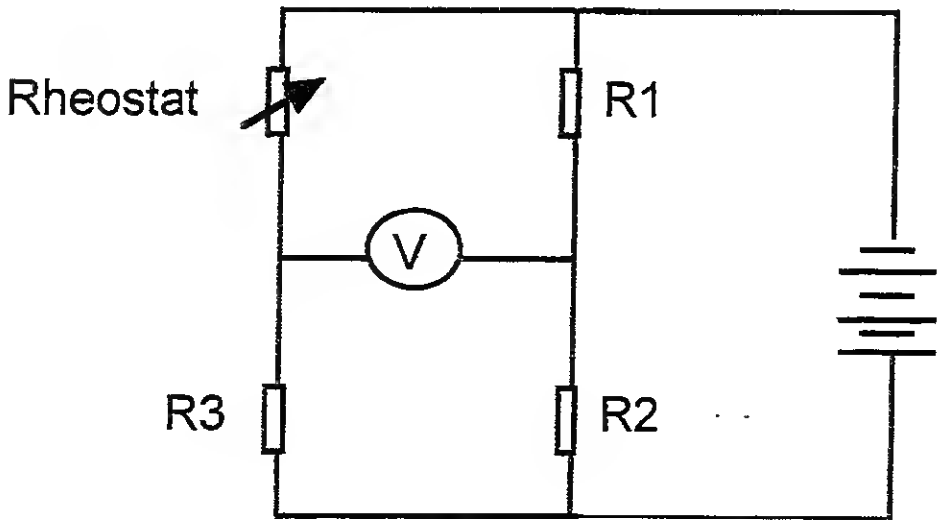
Wheatstone Bridge

Aim: To accurately determine the value of a resistor.

Equipment
Rheostat (variable resistor)
0 -10 Ohms
Resistor 1, 2200 Ohms
Resistor 2, 33000 Ohms
Resistor 3, 100 Ohm
Switch
Power Supply, 0 -12V DC or a 9V battery
Connecting wires, 5
Connectors, 6
Voltmeter

Procedure
Connect the components as in the circuit drawn below.
Turn on the switch and adjust the Rheostat until the voltmeter reads zero.
When the voltmeter reads zero the voltage drop across R1. and the Rheostat is equal and the voltage drop across R2 and R3 is equal.
Using Amperes' Equation :
where R is the voltage of the Rheostat

$$R = R3 \times R1 / R2$$



Results: ____

____

____

Conclusion: ____

____

____

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Wheatstone Bridge

Topics: Electricity

Aim: To accurately determine the value of a resistor.

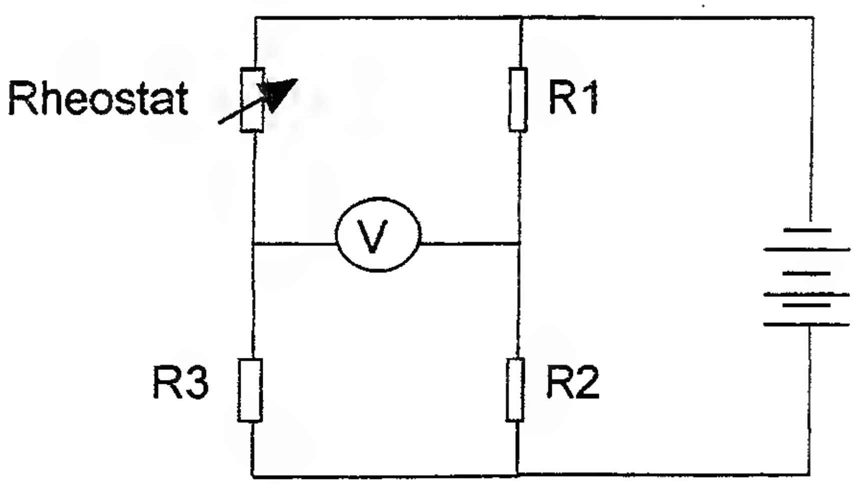
Equipment

Rheostat (variable resistor) 0 -10 Ohms
Resistor 1, 2200 Ohms
Resistor 2, 33000 Ohms
Resistor 3, 100 Ohm
Switch
Power Supply, 0 -12V DC or a 9V battery
Connecting wires, 5
Connectors, 6
Voltmeter

Procedure

Connect the components as in the circuit drawn below.
Turn on the switch and adjust the Rheostat until the voltmeter reads zero.
When the voltmeter reads zero the voltage drop across R1. and the Rheostat is equal and the voltage drop across R2 and R3 is equal.
Using Amperes' Equation :
where R is the voltage of the Rheostat

R = R3 X R1/ R2



Result: The Resistance of the Rheostat is 6.7 Ohms.

Conclusion: The Wheatstone Bridge determines the value of resistors in relation to other resistors and so its accuracy is dependent on the accuracy of the three fixed resistors. The bridge is independent of the source voltage.

Risk Level: Low Hazard

STUDENT:____________________

199

Xylem Tubes

Aim: To observe the action of liquid transport vessels known as Xylem tubes .

Equipment

Bunch of fresh celery
Beakers, 500ml, two
Saffranin 0.3%, 200ml
scoupel
Sodium Chloride

Procedure

Add 100ml of Saffranin solution to each beaker.
Add 3 teaspoons of sodium chloride to one beaker.
Cut the base of some celery stalks so the base is flat and the stalk not so long as to topple the beaker.
Leave the stalks in the beakers overnight.
Cut slices of the celery stems for observation .
In the space below, draw a section across the celery stem, labelling any parts you can identify.

Results: ____

____

____

Conclusion: ____

____

____

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199

Xylem Tubes

Topics: Plants

Aim: To observe the action of liquid transport vessels known as Xylem tubes .

Equipment

Bunch of fresh celery
Beakers, 500ml, two
Saffranin 0.3%, 200ml
scoupel
Sodium Chloride

Procedure

Add 100ml of Saffranin solution to each beaker.
Add 3 teaspoons of sodium chloride to one beaker.
Cut the base of some celery stalks so the base is flat and the stalk not so long as to topple the beaker.
Leave the stalks in the beakers overnight.
Cut slices of the celery stems for observation .

Result: The dye was drawn up into the celery stems, particularly in small circular regions near the stem perimeter. The dye did not travel far when sodium chloride was present in the solution.

Conclusion: Plants draw water from the soil through vascular bundles called Xylem tubes located in the stem periphery. Salt opposes the process since Osmosis is a major driving force to the process.

Risk Level: Low Hazard:

STUDENT:_______________

200 "g" and an Air Track

Aim: To determine the acceleration due to gravity by vector analysis of acceleration on a sloping air track.

Equipment

Linear Air track
Air blower
Light Gates
Event timer
wooden block, 10X30X5cm
Tape measure

Procedure

Set up the air track and blower .
Prop one end of the track mounts onto the wooden block.
Measure the rise of the track over its length (x). _______m
Measure the length of the track.(y). _____m
Measure the distance between the light gates (L)._____m
Hold the glider at the upper light gate so its "flag" is just clear of the light beam.
Allow the glider to slide down the track, recording the time required to travel between the light gates (t).
Repeat six times.

$L = 1/2\ at^2$, therefore $a = 2L / t^2$

$g = ay / x$

Calculate an average figure for 'g' with residual error.

t	a	g
	2L / t2	ay /x
	Average	

Results: ____

____

____

Conclusion: ____

____

____

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200

"g" and an Air Track

Topics: Forces

Aim: To determine the acceleration due to gravity by vector analysis of acceleration on a sloping air track.

Equipment

Linear Air track
Air blower
Light Gates
Event timer
wooden block, 10X30X5cm
Tape measure

Procedure

Set up the air track and blower .
Prop one end of the track mounts onto the wooden block.
Measure the rise of the track over its length (x).
Measure the length of the track. (y).
Measure the distance between the light gates (L).
Hold the glider at the upper light gate so its "flag" is just clear of the light beam.
Allow the glider to slide down the track, recording the time required to travel between the light gates (t).
Repeat six times.

$L = 1/2\ at^2$, therefore $a = 2L / t^2$

$g = ay / x$

Calculate an average figure for 'g' with residual error.

Result: Results for g should be about 9.6 plus or minus 0.2 , since air friction will still hold values below the theoretical 9.8m/s/s.

Conclusion: The gravitational acceleration down a slope is proportional to the Sine of the slope angle.

Risk Level: Low Hazard: